ILLUMINATING ENGINEERING

JULY 1953

Quantities and Concepts in Illuminating Engineering
Report on Tests of Luminous Panel Systems
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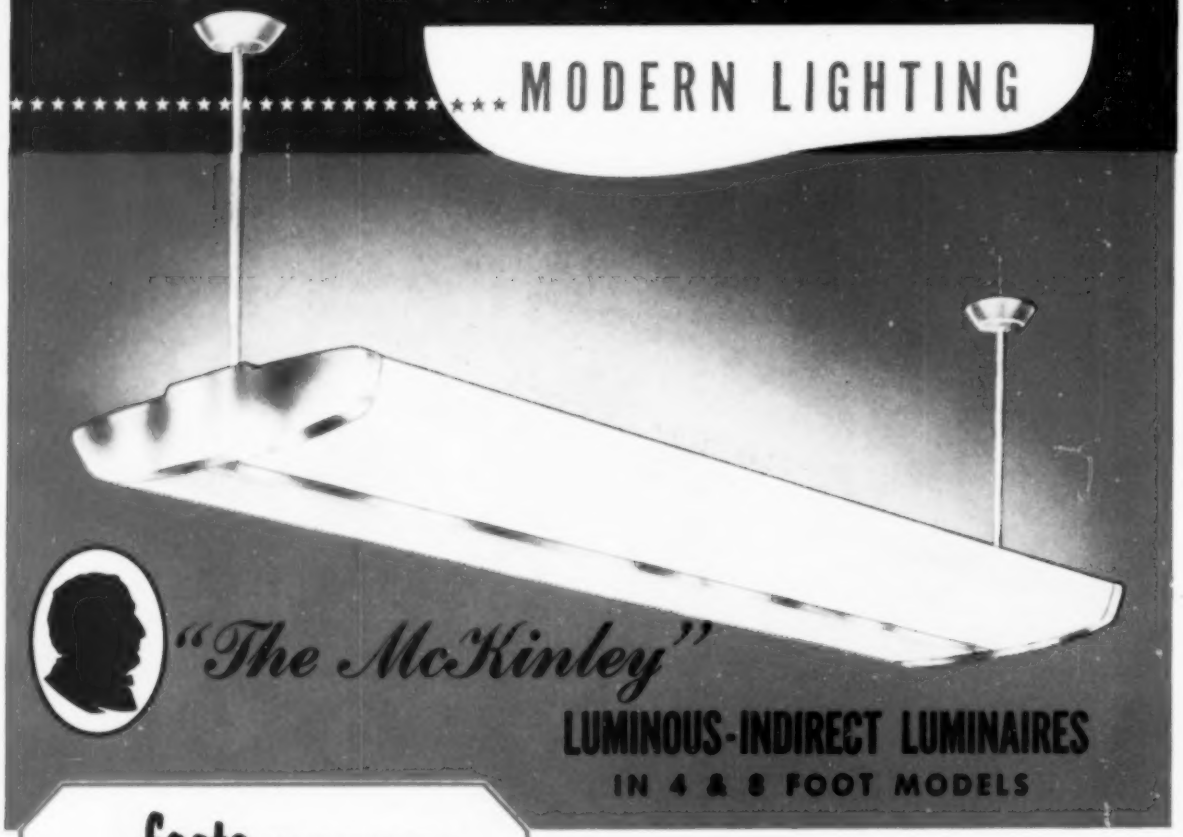

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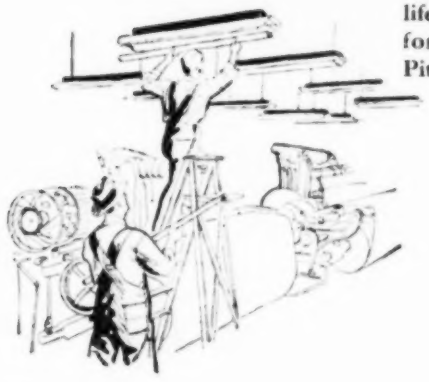

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

JULY
1953

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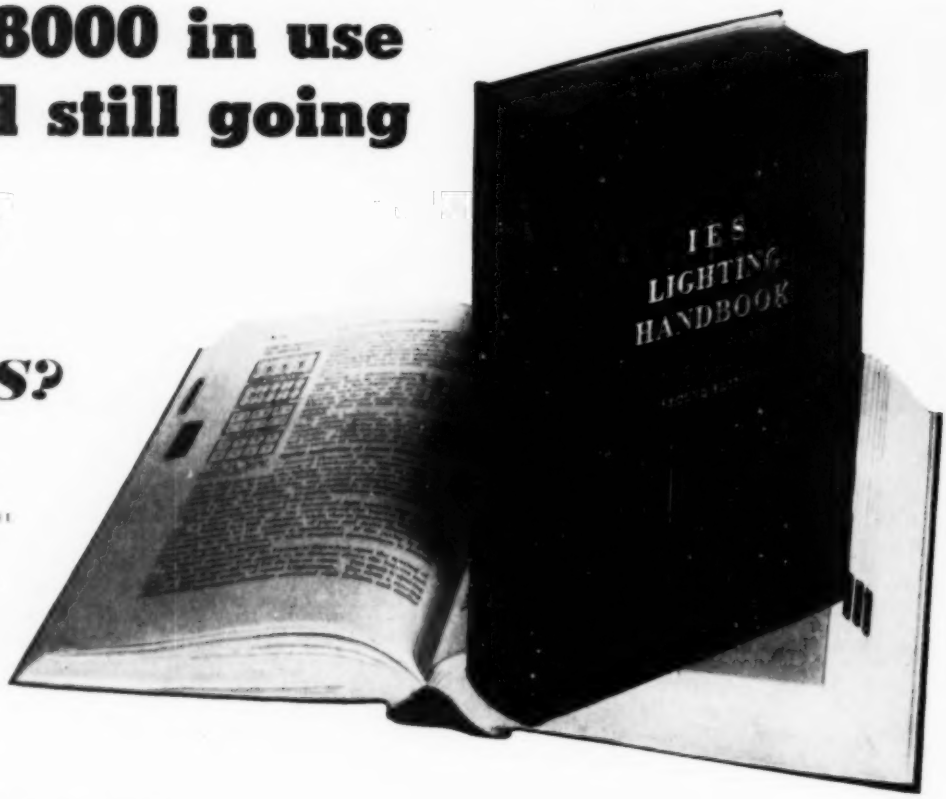

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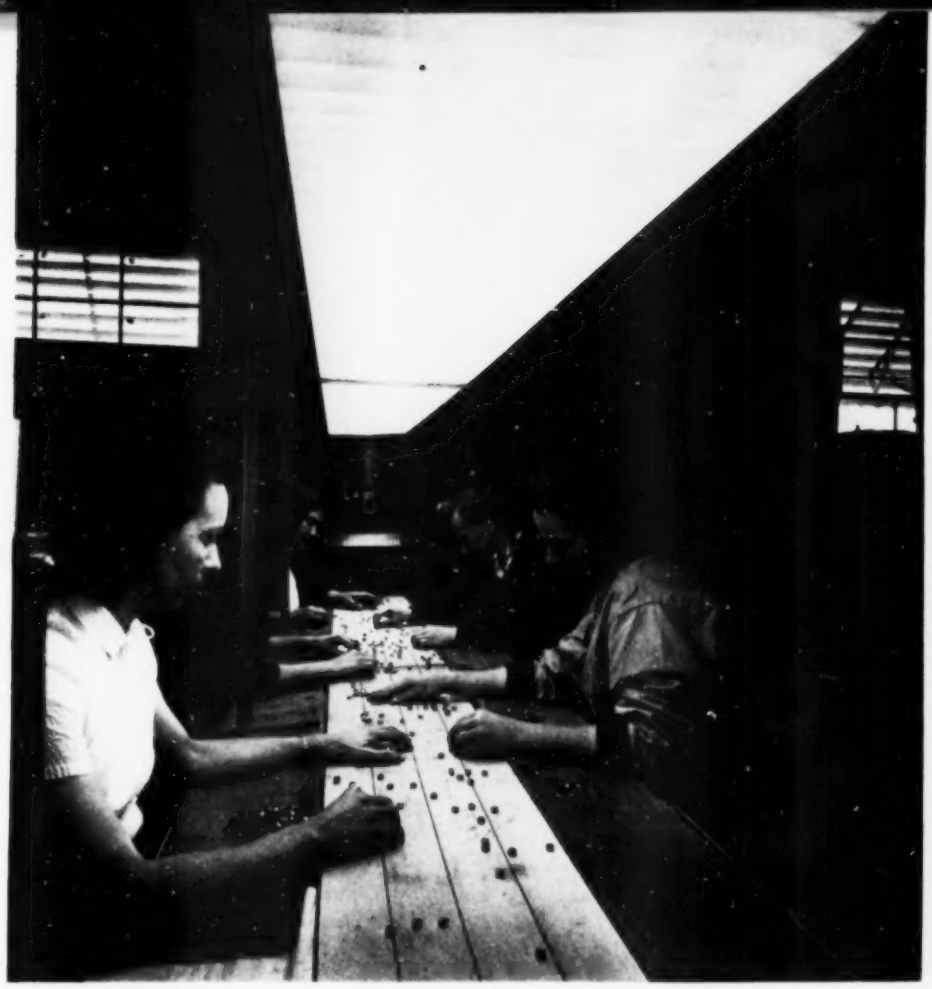


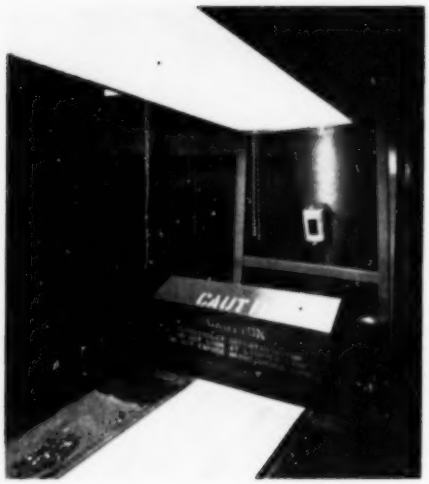
Applied Principles Solve Inspection Problem

By RICHARD B. HATFIELD

SORTING and inspection problems at Industrial Aids, Inc., in Compton, California, were several-fold. The articles to be inspected were small and specular. Details to be discerned were even smaller. They moved past inspectors relatively quickly. Decontamination was required to reduce infection from dirty objects being handled in the sorting process.

Industrial Aids, Inc. is a service type of business engaged in reclaiming valuable aircraft parts for re-use by aircraft assembly plants. Various parts, mainly small nuts, bolts, screws and rivets are reclaimed from floor sweepings from aircraft plants by means of a series of sorting and inspection tables. After reclaimed articles are separated from the trash and debris, they are inspected and sorted,

The solution to this lighting problem won third prize in the contest for "My Most Interesting Lighting Job" conducted by the Southern California Section. Mr. Hatfield is a lighting consultant with the Southern California Edison Co., Compton, Calif.



counted, boxed and returned to the aircraft assembly plants. The floor sweepings arrive at the plant in truck loads and are dumped into hoppers which remove the paper and trash. Metallic parts are then roughly sorted by mechanical screening, and conveyed to a final sorting process done by women employees who hand-pick the various types and sizes of objects as they move along conveyor belts.

Small, shiny, moving objects, details of which must be discerned quickly, make a severe seeing task in this operation. High levels of good quality lighting were definitely called for in its solution. Two high-level four-tube industrial slimline units with 430 ma lead-lag ballasts were mounted 26 inches above the table. To counteract the brightness inherent in this type of fixture, a corrugated plastic diffusion unit was attached. Average level over the 12-foot length of belt is 225 footcandles, with minimum specular reflection and maximum comfort.

The following brightness readings were taken at the same angles of view as used by the employees:

Conveyor belt	15.5 footlamberts
Blue cloth covered panel to side of belt	5 footlamberts
Plastic diffuser on unit	90 footlamberts

Decontamination of the reclaimed parts was accomplished with high-intensity short-wave ultraviolet units placed over the conveyor unit which separates the reclaimed parts from the floor sweepings, with a smaller unit at the head of each sorting table. An estimated 70 per cent decontamination of the material is obtained.

New Standard Practice For Street and Highway Lighting

The long awaited American Standard Practice for Street and Highway Lighting, approved by the American Standards Association and greeted with acclaim by street lighting authorities all over the country, is available from I.E.S. Headquarters as a 32 page booklet. In every way the latest information available in its field, the new Standard Practice is the result of studies by the I.E.S. Committee on Street and Highway Lighting since 1927, the last such Practice being published in 1947.

Liberally illustrated with tables, charts and drawings, the booklet is divided into sections such as: Classification of Streets and Highways; Classification of Luminaire Light Distributions; Design of Street and Highway Lighting; Situations Requiring Special Consideration. Appendices give background lighting information: Fundamental Aspects of Roadway Lighting; Data on Luminaire Performance and Computation; Typical Street Lighting Layouts; and Measurements.

Acclaimed by street lighting authorities over the country, the new Practice represents a great step forward in improved lighting for America's side streets as well as our superhighways. Copies may be ordered through the Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

UL—and the Lighting Industry

By F. K. HANLIN

FOR THE past 59 years, Underwriters' Laboratories, Inc., has played a major role in the maintenance of public safety in electrical installations. Through a double program of establishing standards of construction and performance for electrical equipment and of testing commercial equipment for conformance to these standards, this testing station sponsored by the National Board of Fire Underwriters has achieved a record of service which indicates the early concern of insurance companies with the problems of safeguarding life and property from the inherent dangers of a rapidly widening use of electricity.

When the Columbia Exposition introduced the first large scale application of electric lighting in Chicago in 1893, insurance interests were quick to recognize the potential fire hazards. Accordingly, men were assigned to investigate each fire of an electrical origin at the fairgrounds, in an effort to locate the faulty equipment and determine the reason for its incendiary performance. In the Chicago area at the same time, the insurance companies were also sponsoring an investigation of automatic sprinklers. To consolidate laboratory equipment and expand their activities, the men conducting these studies joined forces in 1894 to found Underwriters' Laboratories, Inc.

Lighting Fixture Standards

Throughout its history, UL has found itself vitally concerned with the lighting industry. Of primary interest to most branches of this industry are the considerations behind the Laboratories' "Standard of Electric Lighting Fixtures" and the activities which must take place before the "Underwriters' Laboratories Inspected" label may be affixed to a unit of lighting equipment. The limited description of these considerations and these activities which follows gives a fair indication of what UL is doing for each of a large and growing number of products.

UL consideration of a lighting fixture begins with the "Standard of Electric Lighting Fixtures." Based on engineering principles, test and field experience, and an appreciation of the problems of manufacturing, installation, and use, this standard provides specifications for the construction of the equipment and requirements for its performance—both from the standpoint of safety. Industry cooperation is an essential part of the process of establishing these qualifications. For example, when further experience, investigation, or advancement of the art makes a specification change desirable, UL requests comments on the proposed revision from all manufacturers whose products are listed under the standard in question. Such comments assist materially in the development of specifications which satisfy the demands of safety and yet avoid requirements that are impractical from the manufacturing standpoint.

Fixture Testing

As Underwriters' Laboratories do not solicit work, it is the responsibility of each manufacturer to apply for a listing of his product and for the UL follow-up "Inspection Service" after this listing has been extended. Once application is made, representative samples of the product are examined for compliance with the established standard for that class of fixture. In determining the nature and extent of the examination, fixtures are grouped into two broad classes: (1) those intended for installation in ordinary locations, and (2) those intended for installation in hazardous locations. While fixtures in both groups are checked for the hazard of fire or electric shock, those in the hazardous location class are also checked for the danger of ignition of inflammable gases and vapors or combustible dusts.

Electric shock hazard in fixtures can be reduced to satisfactory levels by providing adequate insulation for the voltages involved, maintaining the proper electrical spacings, bonding all exposed metal to insure grounding, and exercising care in assembly and design. These conditions can be controlled during manufacture and can be checked by simple inspection. Fire hazard from excessive temperature generated by the fixture is dependent, to a great extent, on the conditions found in actual service. For this reason, simulated in service oper-

AUTHOR: Service Engineer, Underwriters' Laboratories, Inc., Chicago, Ill. Paper submitted through Chicago Section Papers Committee

Figure 1. Testing a surface-mounted ceiling fixture for ordinary locations under conditions representing actual service.

Figure 2. Testing a recessed type fixture for ordinary locations under conditions representing actual installation.

ation is a necessary part of UL examinations. However, it has been determined that with some fixture designs, the maintenance of certain dimensions is sufficient to insure acceptable temperature characteristics. Fixtures constructed within these limitations are approved without further test.

Certain surface-mounted or recessed ceiling fixtures fall outside these dimensional limitations and can serve as examples of typical tests for temperature performance.

Simulated Installations

A surface-mounted incandescent luminaire is normally mounted on the ceiling directly below an outlet box. It is essential that excessive temperatures do not develop where the unit touches the ceiling or around the branch circuit conductors in the outlet box. During test, such a fixture is mounted on a simulated ceiling of cellulose fiberboard secured to a wooden frame, with the outlet box recessed into the ceiling section. The unit is then equipped with lamps of the wattage corresponding to the marking on the fixture, and it is lighted until constant temperature is attained at critical points on the fixture, on the ceiling, and inside the outlet box (Fig. 1). The maximum temperature to which the combustible materials commonly used in ceiling construction can be exposed has been found to be 90°C. The temperature on the conductors inside the outlet box cannot exceed 60°C, as this value is specified by the National Electrical Code for branch circuit conductors in building wiring.

Lighting fixtures of the recessed type are normally mounted with the fixture body extending up into a dead air space above the ceiling. As this precludes the possibility of using moving air to cool the fixture surfaces, the heat developed must be dissipated by radiation or through ventilating openings into the dead air space. During test, the recessed fixture is mounted in a rectangular box which represents the ceiling cavity in which it would be installed. The box is reasonably airtight, but not sealed, and the dimensions are such that each wall is one-half inch from the nearest part of the fixture (Fig. 2). The National Electrical Code requires that this type of fixture be constructed and installed so that adjacent combustible material will not be exposed to temperatures above 90°C, and that the recessed portions of the fixture enclosure, other than at points of support, will be at least one-half inch from combustible material.

Units for Hazardous Locations

In addition to the foregoing inspection for the hazards of electric shock and fire, fixtures designed for installations in hazardous locations must undergo tests to determine the possible danger of ignition of inflammable gases and vapors or combustible dusts. The National Electrical Code divides hazardous locations into three classes:

Class I — Locations in which inflammable gases or vapors are or may be present in air in quantities sufficient to produce ignitable or explosive mixtures.

Class II — Locations in which combustible dust is present.

Class III — Locations in which easily ignitable fibers or flyings are present, but are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.

While the National Electrical Code recognizes variations in the potential hazards within Classes I and II and acknowledges these with sub-classifications, for the purpose of general illustration this discussion will describe the requirements of fixtures for use in Class I and II locations without regard to sub-classes.

Explosion-Proof Units

Because tests have shown that it is practically impossible to prevent gases or vapors from entering the enclosure of a lighting fixture, UL standards specify that Class I fixtures must be constructed to withstand an explosion which may occur within the fixture without allowing the flame to spread from the interior of the enclosure to the surrounding inflammable atmosphere. Since this equipment is not necessarily vapor-tight, it is misleading to use the term "vapor-proof" to describe explosion-proof construction. Because surfaces heated to a sufficiently high temperature can ignite gas or vapor-air mixtures, the maximum surface temperatures of a Class I fixture must be measured to make sure they are safely below the ignition point of the explosive mixture involved.

In testing explosion-proof fixtures, a special carburetor system is used to maintain accurate control of the gas or vapor concentration in the explosive mixture. This concentration is measured through the use of the gas analysis equipment illustrated in Fig. 3.

Technicians prepare the fixture for explosion tests by drilling and tapping openings for inlet and outlet connections to the carburetor system, for spark plugs to ignite the explosive mixture, and for the connection of pressure recording instruments. The fixture is then installed in a test box (Fig. 4) which is also connected to the carburetor system so that it, too, can be filled with the explosive mixture. If, when the mixture inside the fixture is ignited, the flame does not escape to ignite the surrounding explosive atmosphere in the test box, the performance of the unit is acceptable.

Dust-Tight Units

Class II fixtures, designed to perform satisfactorily in the presence of combustible dust, must, according to UL specifications, be constructed so that dust cannot enter the fixture enclosure. The tests for these units make certain that the joints in the enclosure are dust-tight and that the temperatures attained on dust-blanketed outer surfaces are not sufficiently high to ignite the dust.

During test, Class II fixtures are installed in a chamber connected with dust circulating equipment as shown in Fig. 5. A dust-air mixture is blown through nozzles against the joints in the fixture, while intermittent lighting of the unit pro-

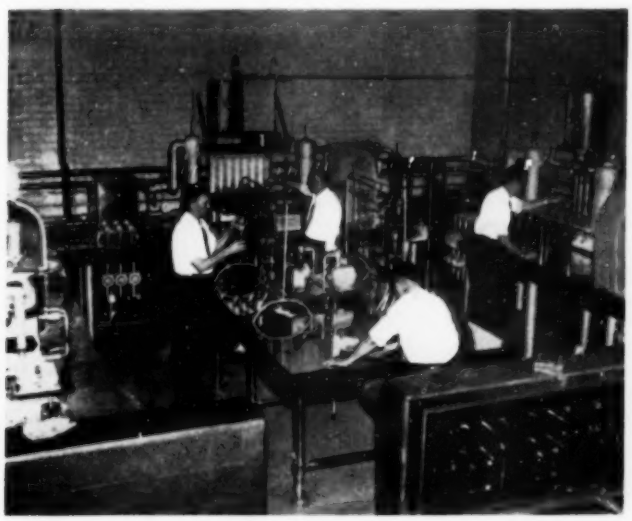


Figure 3. Gas analysis apparatus at Underwriters' Laboratories used to check explosive mixtures of gasoline, ether, etc., with air during test of explosion-proof electrical equipment for munitions plants, oil refineries, hospitals, and other hazardous locations.

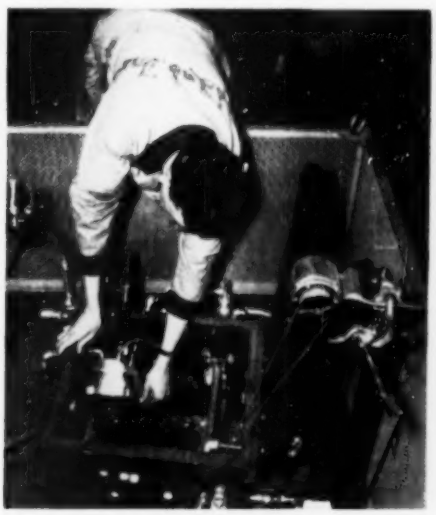


Figure 4. Testing an explosion-proof fixture for use in the presence of inflammable gases and vapors. Fixture is installed in a test box connected to a carburetor system.

Figure 5. Testing a dust-tight fixture in the dust chamber at Underwriters' Laboratories. These tests for use in atmospheres of explosive dusts represent months and years of actual factory use.

vides cycles of heating and cooling. Layers of dust are allowed to accumulate on the fixture as it operates at normal electrical load, and the surface temperatures are measured by thermocouples. At the conclusion of the test, if no dust has entered the enclosure and if there is no ignition or charring of the dust collected on the fixture, the performance is acceptable.

The above test descriptions are intended only as an indication of the type of investigations undertaken by Underwriters' Laboratories in the field of lighting. Equally important to lighting equipment manufacturers and others concerned with the application of electrical illumination are the UL standards and tests for thousands of other electrical components.

Inspection Service

A necessary follow-up to the initial testing of a product by UL is the previously mentioned "Inspection Service" for units which have been approved and are in production. This inspection service takes place at the factory where the fixtures are manufactured. The manufacturer is permitted to attach the "Underwriters' Laboratories Inspected" label to such of his production of a listed fixture as is found, by his own inspection, to comply with the applicable UL standards. Representatives of the Laboratories, conducting frequent inspections at the factory, examine a sufficient portion of the manufacturer's labeled product to provide a practical countercheck on the manufacturer's own inspection service.

Industry Cooperation

Underwriters' Laboratories is a non-profit organization incorporated for service. The cost of its operations is borne by the individual manufacturers who make use of its facilities on a cost basis for the examination of a product and who pay fees to maintain the factory inspection service on listed products.

Summing up, it can be said that the chief purpose of this comprehensive test and inspection program is to provide assurance, both to the manufacturer and the user, that any piece of equipment bearing the UL label, if installed and used in accordance with the provisions of the National Electrical Code, will be reasonably free from danger of electric shock, fire, or explosion.

To this work of Underwriters' Laboratories must go much of the credit for public confidence in the everyday use of electricity and the universal acceptance of electrical equipment. From the cooperative nature of this program, it is evident that its continuing success depends upon the wholehearted support and participation of the lighting industry.

[Editor's Note: This article is one of a series on the characteristics of materials and services relating to the lighting industry. Previous articles in this series are: "Characteristics of Plastics," December 1951; "Characteristics of Porcelain Enamel," July 1952; "Characteristics of 300-Degree White Baked Enamel Finishes," February 1953; and "Characteristics of Alzak Aluminum," March 1953. Future articles are planned for tungsten, acoustical materials, glass, etc.]

I.E.S. Emblem

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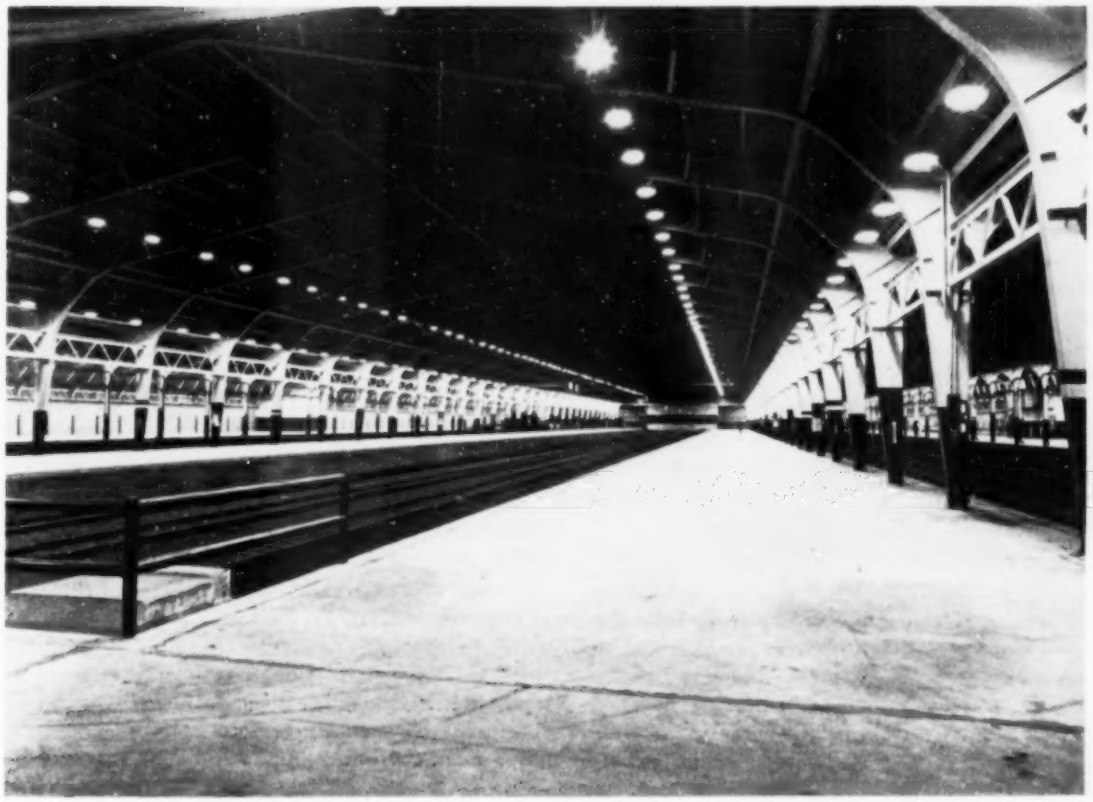

INSTALLATION AT MISSOURI PACIFIC CONSOLIDATED FREIGHT TERMINAL, ST. LOUIS, MISSOURI.

Lighting a Railway Freight Station

LIGHTING OBJECTIVE: To illuminate the work platforms beside the tracks in a railroad freight terminal.

GENERAL INFORMATION: The platform shown above is 30 feet wide and 750 feet long. The outside platforms are 51 feet wide. The pavement concrete and tops of columns are white (reflectances 56% and 65% respectively). There are four sets of tracks between each pair of platforms.

INSTALLATION: A total of 696 300-watt glass-covered luminaires (Benjamin No. 5644 with clear lamps) are installed as indicated in Fig. 2. After three months operation the two center platforms received 14 footcandles illumination from luminaires mounted at 20 to 25 feet; units mounted at 14 to 18 feet provide 18 footcandles on the outer platforms. Brightnesses of a central bay area are as follows:

platform	46 ft L
columns	
bottom	28 ft L
top	60 ft L
track area	9 ft L

Lighting inside the cars is provided by 100-watt incandescent filament lamps in wire guards (Protex No. 104) on extension drop cords with spring rewind reels (Protex No. 901, manufactured by Daniel Woodhead Co., 15 N. Jefferson Street, Chicago). These units are suspended in pairs overhead every 44 feet along the platforms.

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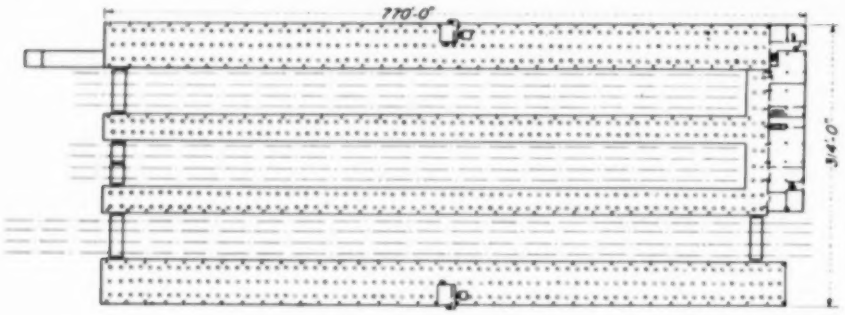


Figure 2 (above) Plan view of platforms *Electrical World*

Figure 3 (right) Close-up of reel and portable lamp used inside freight cars

Lighting designed by A. L. Kelly, Electrical Engineer, Missouri Pacific Lines.

Lighting data submitted by Roger W. Renkel, Industrial Lighting Engineer, Union Electric Company of Missouri, St. Louis, as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Performance vs Installation—Luminous Panel Systems

By BENJAMIN SCOTT BENSON, JR.
ERIC H. CHURCH

Exactly how deep should a cavity be for the best performance from a luminous ceiling? What should be its reflectance? What lamp spacing is best? To determine these factors, comprehensive tests were conducted by the authors in an actual room having a translucent panel ceiling system. This paper reports their results and conclusions.

TRANSLUCENT panel ceiling systems (luminous ceilings) have been the subject of a considerable number of papers, talks, discussions and claims. It is not the intent of this paper to discuss the merits of this type of lighting system one way or the other, but to tell the reader what happens when the system is installed in various ways.

The translucent panel system usually consists of a light-source system of bare fluorescent lamps mounted above a pendent secondary ceiling of modular translucent panels. While the entire system can be coupled together in one inflexible lighting entirety, it is usual to find that the light source system is more-or-less divorced from the translucent panel system. This last is one of the good features of the overall method of lighting in that it provides great flexibility in illumination design to meet a wide range of footcandle and space requirements. Because of its very flexibility, however, it poses the problem of predicting lighting results.

In the *I.E.S. Handbook*,[1] for example, mention is made only that the depth of cavity should be kept as shallow as possible and that the efficiency of the system will decrease rapidly as this depth is increased. Nothing informs the reader *how much* of a decrease might be expected for a given increase in depth. Since the cavity, itself, acts as the reflector for the bare lamps, the reflectance of the cavity paint plays an important part in the lighting efficiency of the entire installation. The *Handbook* covers this important aspect by giving formulae to determine the apparent reflectance of the panels and the efficiency of the entire system. Just how much this means to the typically busy lighting man is problematical.

In order to determine just how these factors influence the lighting results in actual practice a translucent panel ceiling system was installed under various conditions in a typical grade school classroom and the results carefully measured.

AUTHORS: Benjamin Electric Manufacturing Co., Des Plaines, Illinois.

The room used for the study was one previously used for similar test work[2] and kindly made available once more by a sympathetic and understanding school board. Room data were as follows:

Length — 32 feet
Width — 24 feet, 8 inches
Height — 11 feet, 11 inches (to existing ceiling)
Reflectances — floor, 14 per cent
walls, 40 per cent (average)
ceiling, as follows.

The translucent panel ceiling system (Fig. 1) consisted of bare fluorescent lamps mounted between channels and metal "V" strips supporting three-foot squares of corrugated diffusing plastic. The lamp channels were so arranged that they

Figure 1. Interior of cavity showing arrangement of lamps and translucent panels.

could be mounted either directly against the cavity ceiling or 12 inches below it. Provision was made for mounting and operating 96-inch, T-12, standard warm white fluorescent lamps at 425 mils on 36-inch (and in one case 18-inch) centers. The panel support strips were so suspended that the diffusing panels could be mounted various distances below the cavity ceiling.

The diffusing panels were fabricated of .015-inch rigid vinylite plastic having a measured light transmittance of 43 per cent and a reflectance of 55 per cent. Plastic material having these particular values of transmittance and reflectance was specifically selected after a thorough study of *all* the factors involved in the design of a luminous ceiling system. The material for a diffusing panel depends for its diffusion upon the amount of opacifier present in the sheet. In order to obtain higher diffusion the amount of opacifier must be increased and this acts to decrease the transmittance while increasing the reflectance. The higher the amount of diffusion the shallower can be the cavity depth for a given lamp spacing — an important aspect in design today with the lower ceiling heights of today's modern architecture. According to the *Handbook* the transmittance of the diffuser should be 50 per cent with lamp spacing not to exceed 1.5 times the mounting height above the diffuser for good uniformity of brightness. The diffuser material used in this instance had a transmittance of 43 per cent. With a cavity reflectance of 85 per cent this lowered transmittance is only 4.5 per cent less in system efficiency but permits a lamp spacing of twice the mounting height for good uniformity of brightness. For a 36-inch lamp spacing this reduces the necessary cavity depth by six inches.

In order to study the effect of cavity reflectance on lighting performance the ceiling and side walls of the cavity were finished with glossy paints having average reflectances during various tests of 70.7, 77.0 and 84.4 per cent.

Throughout the tests temperatures and line voltages were carefully recorded and results tabulated to 72° F room temperature and rated line voltage.

Table I gives the average initial footcandles at 100 hours of burning for the various tests together with their computed coefficients of utilization.

With the lamps ceiling-mounted it was found that, for every set of cavity reflectances used, increasing the cavity depth from 12 to 36 inches decreased the resultant illumination by less than three per cent.

In the series of tests using a cavity reflectance of 77.0 per cent with cavity depth of 24 and 36 inches it was found that the resultant illumination in both

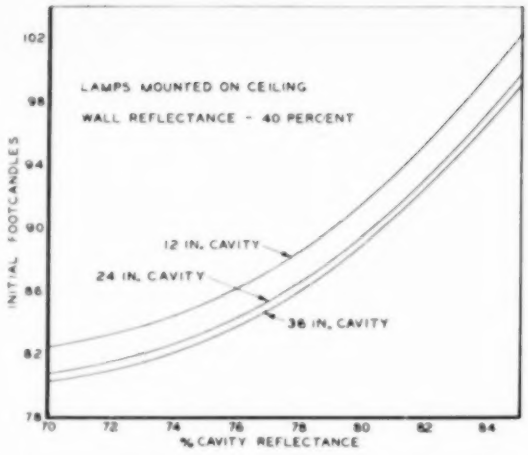


Figure 2. Variation in illumination level due to cavity reflectance.

cases increased by about two per cent when the lamp channels were lowered to a point 12 inches below their original ceiling mounted position.

The most significant variations in resultant illumination were occasioned by increases in the cavity reflectance (Fig. 2) with an increase of 19.2 per cent in reflectance giving a 21.8 per cent increase in illumination.

In the one instance where the quantities of lamps were doubled (18-inch spacing) the resultant illumination was increased by only 83 per cent (rather than by 100 per cent). This was due to the increase in cavity interference offered by the additional lamps themselves plus a reduction in light output of all lamps due to the higher ambient temperature in the cavity from the increased power consumed by the system.

The effect of cavity depth on brightness uniformity over the diffusing panels at ceiling mounted 36-inch lamp spacing is shown pictorially for a 12-inch cavity (Fig. 3), a 24-inch cavity (Fig. 4)

TABLE I.

Cavity Reflectance	Lamp Spacing	Lamp Channel Suspension	Cavity Depth	Average Foot-candles*	Coefficient of Utilization
70.7%	36 in.	0 in.	12 in.	82.7	.400
70.7%	36 in.	0 in.	24 in.	81.0	.392
70.7%	36 in.	0 in.	36 in.	80.5	.389
77.0%	36 in.	0 in.	12 in.	87.3	.422
77.0%	36 in.	0 in.	24 in.	85.3	.413
77.0%	36 in.	0 in.	36 in.	84.8	.410
77.0%	36 in.	12 in.	24 in.	87.3	.422
77.0%	36 in.	12 in.	36 in.	85.5	.414
77.0%	18 in.	12 in.	24 in.	159.8	.386
84.4%	36 in.	0 in.	12 in.	100.7	.486
84.4%	36 in.	0 in.	24 in.	98.5	.476
84.4%	36 in.	0 in.	36 in.	97.8	.473

*Initial at 100 hours of burning.

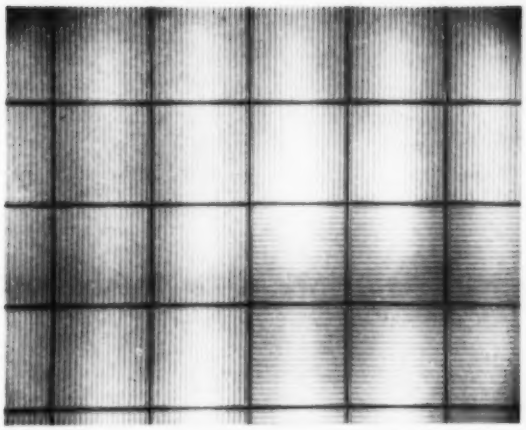


Figure 3. View of translucent panels with lamps ceiling-mounted and 12-inch cavity depth. (One quadrant shows panel ribs at right angles to lamps.)

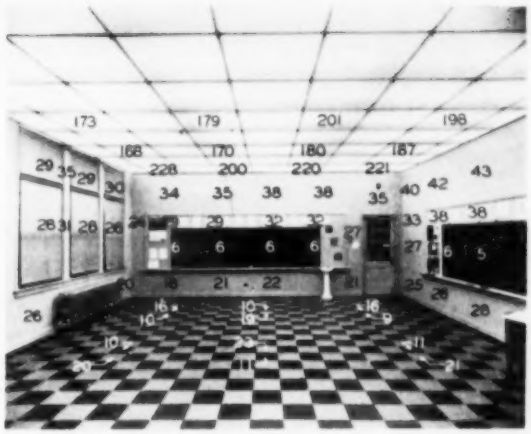


Figure 6. Room brightnesses with lamps ceiling-mounted and 12-inch cavity depth.

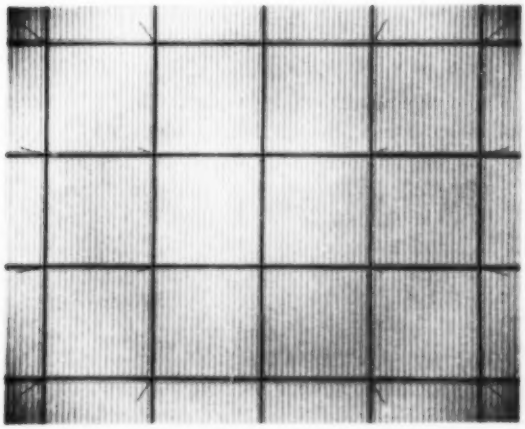


Figure 4. View of translucent panels with lamps ceiling-mounted and 24-inch cavity depth.

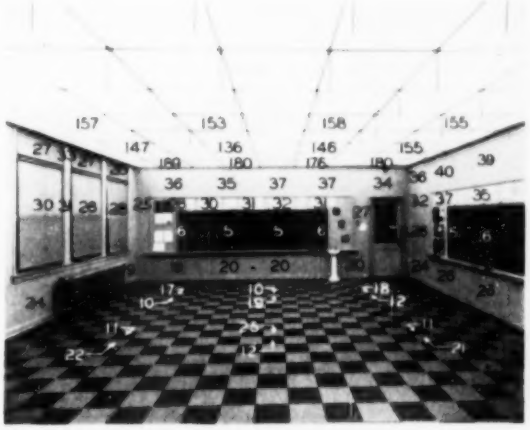


Figure 7. Room brightnesses with lamps ceiling-mounted and 24-inch cavity depth.

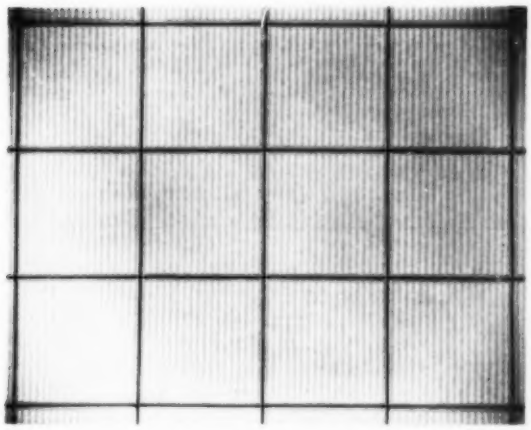


Figure 5. View of translucent panels with lamps ceiling-mounted and 36-inch cavity depth.

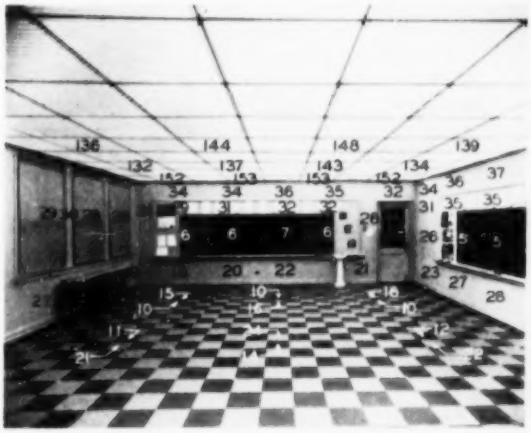


Figure 8. Room brightnesses with lamps ceiling-mounted and 36-inch cavity depth.

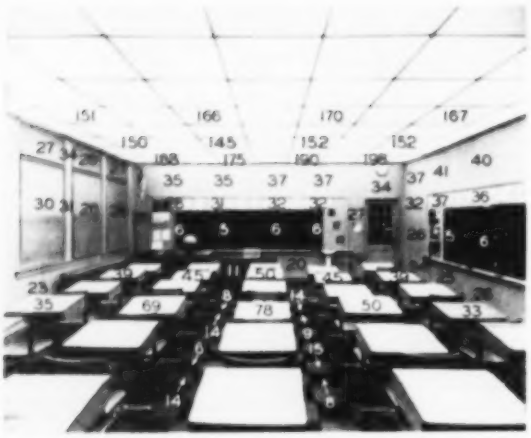


Figure 9. Room brightnesses with lamps ceiling-mounted and 20-inch cavity depth. (Room furnishings in place.)

and a 36-inch cavity (Fig. 5). The 12-inch cavity provides a 9-inch distance from lamp to panel which, for 36-inch lamp centers, make a spacing to distance ratio of 4 to 1 and the resultant streaks of brightness are readily observed. The 24- and 36-inch cavities are reasonably uniform in overall brightness with the corrugations making only a slight pattern of light and shadow over the panels.

General room brightnesses encountered at cavity depths of 12-inch, 24-inch, 36-inch and 20-inch (final installation) are shown in Figs. 6, 7, 8 and 9, for cavity reflectance of 84.4 per cent and lamps ceiling-mounted on 36-inch centers.

Generally speaking the room brightnesses (walls and floor) were of the same general order throughout. Higher room reflectances than those encountered would have added materially to the overall brightness uniformity of the room. The ceiling brightnesses recorded were maximum found on the panel indicated. With a 12-inch cavity, measured brightnesses were the highest with lower maximums recorded as the panels were placed farther from the lamps and thus becoming more uniform in brightness. Even though the lowest brightnesses were found for a 36-inch cavity depth (a distance of 8' 11" from floor to panel) it was this panel arrangement that was judged the brightest by the casual observer.

The final installation and room arrangement (Fig. 9) with a 20-inch cavity depth and 84.4 per cent cavity reflectance resulted in an average illumination level of 99 footcandles at 100 hours of lamp life.

In any discussion of translucent panel systems the question is usually asked about what happens in case of fire. For the particular panels used in these tests the plastic material is classed as a self-extinguishing material in that it will not, of itself, support combustion. Tests conducted by the Factory Mutual Laboratories of the type of panel used for the illumination studies resulted in their approval of such application from the fire-safety standpoint.

Conclusions

From the results of the various tests and their evaluation the following is apparent:

A. The higher the cavity reflectance the appreciably higher will be the light output efficiency of the total system.

B. For the given room ceiling height and within the limits of the tests, the cavity depth had little effect on the light output efficiency of the total system.

C. With the particular light reflectance and light transmittance properties of the plastic used in the panels, the ratio of lamp spacing to the distance lamps are above the panels can be as great as 2 to 1 with good brightness uniformity over the panels.

References

1 *I.E.S. Lighting Handbook*, Second Edition. Illuminating Engineering Society, New York, N. Y., 1951.

2. Benson, B. S., Jr., and Church, E. H.: "Grid Systems for Classroom Lighting." ILLUMINATING ENGINEERING, Vol. XLVII, No. 1, p. 15 (January 1952).

I.E.S. National Technical Conference

September 14-17, 1953 Hotel Commodore, New York City

Driveway approaches to the Los Angeles Statler have stainless steel standards, 9 feet 6 inches high with 27-inch reflecting pans. Hidden in the cones of the standards are 300-watt lamps. The two driveway entrances to the hotel are on Wilshire Boulevard (shown at right in view of hotel) and Seventh Street, on the opposite side.

Functional Lighting in the Los Angeles Statler

A modern hotel is a small community in itself, containing shops, service agencies, arcades, as well as the lobbies, lounges and guest rooms which carry on the tradition of "mine host." These various areas, requiring individual lighting treatment, make use of several techniques in the Statler Hotel in Los Angeles.

The patio lighting is from custom-built units, consisting of fan-shaped cans, mounted over the windows. Floodlights are hidden in the foliage and recessed units are installed in the low walls. Pool lighting is from water-tight flush lens units mounted in sides of pool.

Lighting the Public Areas of The Los Angeles Statler

In the arcade to the shops on the ground floor of the hotel, the lighting is from narrow coffers, each containing one 96-inch, 200 ma, T8 fluorescent lamp. Illumination level is 15-20 footcandles. At the far end of the arcade may be seen one of a number of large coffers, or recessed dome-shaped lighting elements, which measure 10 feet in diameter and are lighted around the lower circumference by two rows of cold cathode tubing shielded by a narrow valance.

A level of about 60 footcandles on each chair in the barber shop is provided from continuous rows of three-lamp louvered troffers in combination with lens downlights using 150-watt incandescent lamps.

In the florist shop, lighting is from a louverall ceiling of 2 x 2-foot panels of 2 x 2 x 2-inch cells. Deluxe cool white lamps are used in two-lamp industrial fixtures mounted on 14-inch centers 18 inches above the louver.

Photographs and data on the Statler Hotel submitted by Roy Kreyser, Department of Water and Power, Los Angeles, Calif.

The hotel lobby is reached by escalator from the Seventh Street entrance. The lighting element in the ceiling over the escalator consists of 42 pyramid-shaped cells, each 31 inches square and 21 inches deep. The lens units at the top of each pyramid are 12 inches square and contain 300-watt lamps.

A level of 50-60 footcandles is achieved at the registration desk (right) by recessed three-lamp louvered troffers spaced on 36-inch centers, and by a continuous row of the same type troffer units along the back part of this working area.

At the drug-store food counter, 35 footcandles illumination is provided by a combination of recessed troffers with louver shielding, each containing three standard cool white lamps, and prismatic lens downlights with 200-watt lamps. Smaller downlights are the deep-recessed baffle type using 150-watt R40 lamps.

Lighting Maintenance—
The Case for Disconnecting Hangers

By THAYER B. FARRINGTON
WARD HARRISON

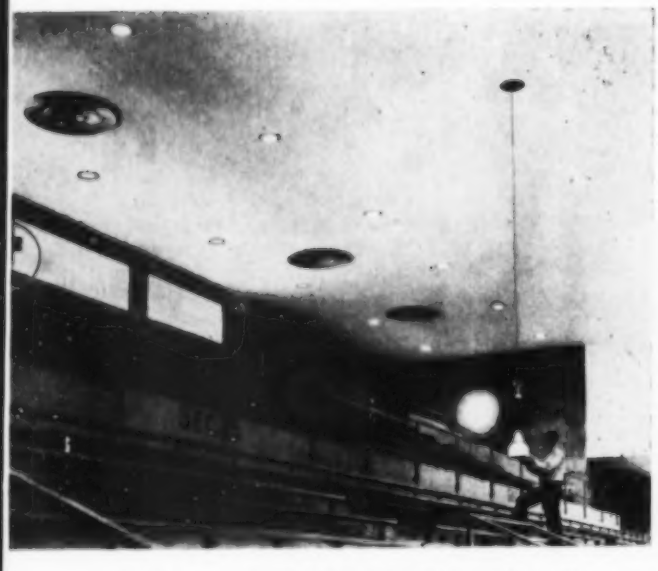
SOME little time ago one of the writers listened to a construction engineer's description of a building which he was just completing. The engineer emphasized that an unavoidable feature of the plant was that machines had to be packed in so closely that there was scarcely room to walk between them. He also mentioned that the trusses were about 18 feet above the floor and that the lighting units were fastened directly to them. He was asked what provision was made for maintaining the lighting. His answer was: "None. I'll be through and far away from that job long before anybody has to think of maintenance." This sounds like an unusual case, but it's unusual only in that the machinery was packed in so closely. Lighting installations are being made every day in which the lamps are 16-18 feet or more above the floor and no advance provision is made for maintaining them.

We may as well face the truth that where maintenance is difficult or hazardous it isn't sufficient simply to make a more liberal allowance for cleaning costs. Rather it means that lighting units just are not cleaned except in a half-hearted way when burnouts occur. Also renewals of outages in such installations require at least two men and are often delayed a considerable time.

A generation ago only meager provision was made for artificial lighting and it was used primarily to supplement natural light on dark days. Night shifts were the exception and it probably did not make a momentous difference in plant operation whether the lights were well maintained or not. Today, in many factories the initial footcandles provided by the artificial lighting system is substantially double the 10 or 20 footcandles of

AUTHORS: President and Consultant respectively, The Thompson Electric Co., Cleveland, Ohio.

Some installations, other than industrial, where disconnecting hangers have been found useful are shown below and on the facing page: (1) gymnasium, where hangers are used above recessed units; (2) a high ceilinged bank; (3) a church with characteristically large luminaires and high ceilings, where pews make access to fixtures difficult, and (4) a legislative assembly room with large and heavy fluorescent luminaires.



natural light available indoors even on clear days; consequently it is in use almost all day, every day. Under these circumstances the only honest choice open to management is that of putting in a reasonable number of lamps and maintaining them well or putting in twice the number really needed and letting maintenance take care of itself. There are few operating men brave enough to double their investment and their consumption of electricity just to be able to cross lighting maintenance off their list of chores. Industry is slowly and reluctantly, but nevertheless surely, coming to the conclusion that they must keep up the footcandles if they want to keep up the production.

There are several solutions to the problem of reaching high mounted lighting units in an orderly way. Most of them have one feature in common: they need to be thought of in advance. One solution is the catwalk; where continuous rows of fluorescent units are placed at a considerable height, catwalks naturally suggest themselves. It is usually necessary to place catwalks on a level with or even above the lighting units. To avoid an awkward working position for the maintenance man provision should therefore be made to swing the fluorescent units up to the height of the guard rail. The cost of catwalks may be estimated at about $10.00 per running foot.

Another method is to maintain lighting units from a crane where a craneway is present. In the best of these systems an extra detachable bridge is provided, which is supported on the crane rails and can be towed along by the crane. Where the crane or crane bridge is used, the reflectors are customarily detached and lowered to the floor, where they can be washed thoroughly. The trend is away from washing in place for another reason as well, namely, that water and detergents may fall on polished metal below and cause troublesome rust spots. As to costs, there has been considerable argument pro and con, especially in the steel industry. Some regard it as an economical method and others, including a department superintendent of United States Steel, take the position that counting the time of the crane operator and the men on the crane bridge and on the floor, it is expensive.

Disconnecting hangers provide a third method of maintenance for high mounted units. Where hangers are installed, the workman remains on the ground and lowers the lighting unit to a convenient position for servicing. The ladder and climbing hazard are completely eliminated and when the unit comes down it is entirely disconnected from the electric circuit — entirely safe. To minimize the hazard to men who handle electrical equipment, some organizations prohibit the use of 440 volts, and in some cases 220 volts, to ground on lighting units. The 1000-watt and 3000-watt mercury lamps require such voltages, but the use of disconnecting hangers keeps these potentials quite inaccessible to the workmen and therefore permissible. Ever since the start of World War II they have been installed for more than 10,000,000 square feet of floor area each year. One helpful factor has been that, upon request, the manufacturer furnishes a complete detailed layout covering the installation of hangers, pulleys, cables and accessories.

At heights of 30 feet or more, clusters of two mercury lamps and one 750- or 1000-watt incandescent are frequently used, the latter for color

improvement and instant relighting after a power interruption has occurred. Such clusters, when spaced on 25-foot centers, will provide something like 40 footcandles of general illumination. Disconnecting hangers are now available with four contacts so that all three light sources in a cluster can be supplied through one hanger and raised and lowered together for servicing. When the light sources are returned to operating position they are exactly as they were before lowering; there is no change in lamp position, orientation or polarity.

Some of our older readers will remember that in street lighting the old open arc lamps were customarily lowered to the street every day for carbon trimming and globe cleaning. Equipment is now available so that lamps used for outdoor lighting either around industrial plants or on the street can once again be lowered for maintenance and in contrast with the old arc installations they are then entirely disconnected from the circuit. Also, there are no loose wires left to swing in the wind; in fact the mechanism is fully enclosed in such a way that the very presence of a disconnecting hanger is hardly suggested.

One rather unusual application of cut-out hangers is in supplying power for portable cords required for electric drills or even portable lamps as are sometimes needed in airplane hangers and similar high buildings with large open spaces. Stretching the cords long distances across the floor from an electric outlet is decidedly objectionable. Wherever disconnecting hangers are used for lighting they can be lowered and extra connections made to them for the needed cord.

High-Level Comfortable Lighting For Dental Operating Rooms

A high level of diffuse illumination — to provide adequate light for the seeing task and minimize contrast with the mouth spot light for the dentist, and to create as comfortable an environment as possible for the patient — was the aim in relighting the dental offices of Dr. Chas. A. Dodge, of Martinez, Calif. A luminous ceiling was chosen for the two operating rooms. Slimline strips, mounted on 24-inch centers above thin corrugated plastic panels, provide a maintained illumination of 60 footcandles with ceiling brightness of 163 footlamberts. Plenum space — lamps to plastic — is 16 inches. Operating room walls are painted light coral and seafoam green with reflection factors of 40 and 55 per cent respectively.

Designed by R. L. Sawyer, Pacific Gas and Electric Co., Oakland, Calif., this installation won third place in the Northern California Section contest for "My Most Interesting Lighting Job."

INSTALLATION AT YONKERS DISTRICT OFFICE OF CONSOLIDATED EDISON COMPANY OF NEW YORK, YONKERS, N. Y.

Dual Lighting for Facade Sign and Sidewalk

LIGHTING OBJECTIVE: To provide silhouette lighting for a facade sign and high-level illumination on the sidewalk below.

GENERAL INFORMATION: The limestone facade of the building (60% RF) is 32 feet long and 5 feet high; the sidewalk is 15 feet wide. The sign letters are 2½ inches deep, finished medium blue semi-glossy porcelain enamel (5 to 10% RF); the capital letters are 26 inches high.

INSTALLATION: Specially designed continuous Alzak reflectors, with 150-watt incandescent filament lamps on 12-inch centers, constructed by the Rambusch Decorating Company provide this attraction lighting. Lamps are shielded at 45-degree angles by the reflector and crosswise louvers. The outward appearance of the all-aluminum unit suggests a balustrade, and provision has been made in the design for the unit also to illuminate flowers and plants in flower boxes placed on top of the parapet wall (Fig. 2). The cheerful lighting of the sidewalk is appreciated by people waiting for buses at this transfer location.

Illumination of sidewalk varies from 45 footcandles maximum at the building line to 18 footcandles at the curb. Brightnesses are as follows:

facade	
top, center	19 ft-L
top, corners	5 ft-L
below letters (in shadow created by projection of letters)	3½ ft-L
letters	0.65 ft-L

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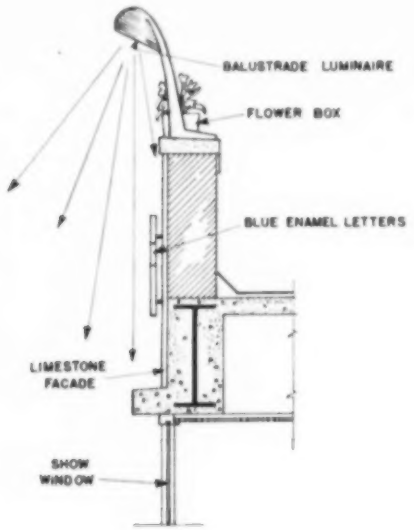

Figure 2. Cross-section of installation.

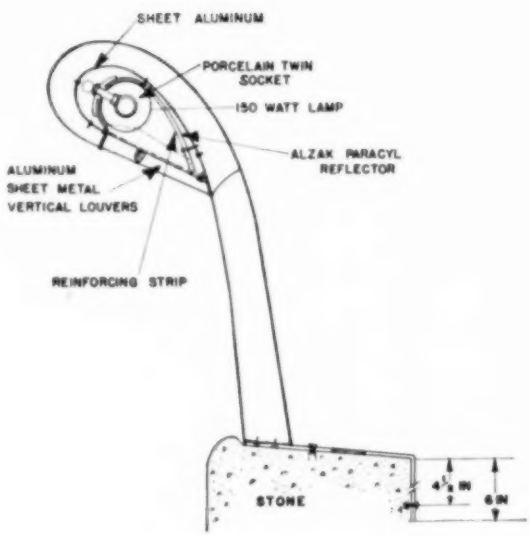

Figure 3. Luminaire detail.

Lighting data submitted jointly by Ralph H. MacVean, Technical Service Division, Consolidated Edison Company of New York (Westchester) and Svend W. Brunn, Rambusch Decorating Company, New York City as an illustration of good lighting practice and to aid in the design of similar installations.

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Basic Quantities and Concepts Used in Illuminating Engineering

By D. M. FINCH

THE OFFICIAL Nomenclature and Photometric Standards of the I.E.S. now in effect are given in the American Standard Z7.1-1942. For ten years this material has been under constant scrutiny and has been subjected to much criticism. This discussion relates to Sections 05. and 10. of Z7.1-1942, and the author solicits general discussion and criticism.

The nomenclature of illuminating engineering is not entirely satisfactory to many engineers and students because of the lack of clarity in the definition of some of the basic quantities. The ambiguities are not serious for nonprofessional use, but are particularly disturbing when one attempts to read or write technical articles in which it is important to have a single clear definition for each word, phrase or quantity that is used to convey a specific meaning.

Fundamentally, only four kinds of quantities are involved in the basic aspects of illuminating engineering dealing with radiant energy transfer, namely: (1) energy, (2) energy density, (3) power, and (4) power density. It is these four quantities that we need to examine carefully and to define fully in terms of their radiation properties within the range of the ultraviolet, visible and infrared spectra. There should be a one to one correspondence between the concepts used for "like quantities" in each specialized field of radiation engineering, such as germicidal, erythemal, fluorescence, illumination, colorimetric, near infrared, or thermal radiation.

Illuminating Engineering should be conceived in a broad sense to include all phenomena associated with electromagnetic radiation in the above spectral range of wavelengths from approximately 0.18 microns to 50 microns. Within these limits we have the ultraviolet from 0.18 to 0.38 microns, the visible from 0.38 to 0.76 microns, and the infrared from 0.76 to 50 microns. All the problems of energy interchange, within this band of wavelengths, are similar and involve either energy or power or the corresponding quantity modified by a special response function. Thus, within the visible range we apply the "luminosity function" to evaluate radiant power in terms of luminous flux. Our choice of defining relationships should, therefore, permit us to transfer from one specialized field to another by merely using the correct "response function" with the spectral energy distribution that is involved.

There is a corollary set of definitions that follow from the basic quantities that involve the processes, the devices, and the properties of devices that are used in conjunction with the radiant energy. For example, photoelectric emission may be considered as a process, a reflector is a device, and reflectance is the property of a device. All these secondary definitions are reserved for a later discussion, since it is believed that they are more readily understood if presented after the fundamental energy relationships are developed.

Before dealing specifically with the derivation of the relationships among the basic quantities, let us examine the nature of the energy system. The localized universe with which we are dealing involves space, time and a specialized form of energy described as *radiant* energy, which has definite properties that are used in defining the terms with which it is associated. Some of these properties will be useful in establishing the basic quantities used in illuminating engineering are:

Radiant Energy in the Ultraviolet, Visible and Infrared Range

1. It originates from a finite physical entity. Generally it is of molecular or atomic origin associated with the motion of atoms or the changes in outer orbit electrons of atoms.
2. A finite size of source having physical dimensions is necessary.
3. The radiant energy leaving the source has electromagnetic properties but for different purposes it may be treated as wave phenomena, as quanta, or with the methods of wave-mechanics. For our purposes we need only recognize the existence of the radiation and its detectable effects; we need not philosophize as to its ultimate nature.
4. The radiant energy travels in straight lines from the source.

AUTHOR: Division of Electrical Engineering, University of California, Berkeley, Calif. Chairman, I.E.S. Committee on Nomenclature.

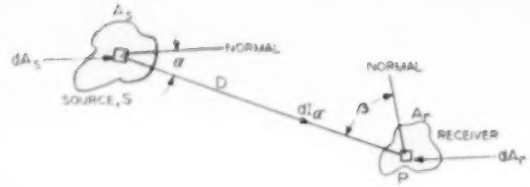


Figure 1.

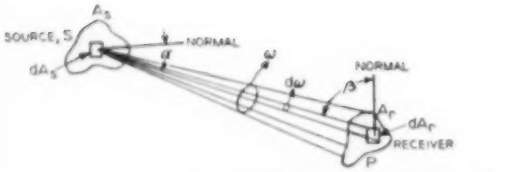


Figure 2.

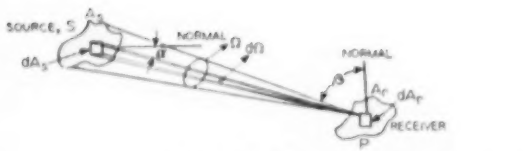


Figure 3.

5. The radiant energy is continuous in space around the source. The spatial distribution may be non-uniform, but there can be no direction of absolute zero emission into the space surrounding the source.

6. The radiant energy may be continuous or discontinuous, insofar as wavelength or frequency is concerned.

7. The radiant energy can only be detected by a change in the form of the energy at the location of the receiver. For example, radiant energy to electrical energy at a photocell, or radiant energy to thermal to electrical at a thermopile.

8. The detector (receiver) of radiant energy must have a finite size.

9. The radiant energy travels at a finite speed. The speed will depend upon the medium through which the radiant energy is propagated and upon the frequency. Radiant energy will travel unattenuated in a vacuum but will be scattered and absorbed in any physical medium.

The above general properties place limits on any system such as is used in illuminating engineering; for example:

A. There must be a light source of finite size.

B. There must be a receiver of the light which has finite size.

C. There must be a space between the light source and the receiver.

D. The space between source and receiver must be completely filled with radiant energy from the source. All solid angles from the source to receiver must contain radiant energy while the source is emitting, but the amount in any direction may be infinitely small.

E. The distances usually used in illuminating engineering will be considered small enough to eliminate absorption and scattering effects.

With such a system there will be a certain *total energy transfer* from the source to receiver in a given period of time; there will be a certain *volumetric density* of the energy at any given time; and there will be a *rate of transfer* of energy. The rate of energy transfer may be described in terms of the dimensions of the source, or of the receiver, or of the volume of the space being filled. These quantities have certain basic relationships which define the building blocks for the nomenclature of illuminating engineering.

A logical order for listing and defining the above concepts is given in the following table.

Radiometric	× Luminosity Function =	Photometric
1. Energy		10. Light (Luminous Energy)
2. Energy Density (Volumetric)		20. Light Density (Volumetric)
3. Power		30. Flux (Luminous Power)
4. Power Density		40. Flux Density (Luminous Power Density)
a. Power Density at a Surface		a. Flux Density at a Surface
b. Power Density in a Solid Angle		b. Flux Density in a Solid Angle
(1) Solid Angle Power Density for Total Source		(1) Solid Angle Flux Density for Total Source
(2) Solid Angle Power Density for Unit Element of the Source		(2) Solid Angle Flux Density for Unit Element of the Source

These quantities may be given names and specifically defined with a symbol, defining equation and dimensional units that can have only one meaning and interpretation. Similarly, by using the proper response functions a set of basic quantities can be set up for all the other radiant energy effects, such as: photographic, germicidal, erythemal, fluorescent color, or thermal. A list of the radiometric and photometric quantities has been prepared using the above sequence and is shown in Table I. The derivations are limited to the photometric quantities normally used in illuminating engineering. The concepts can be readily extended to other than the visual phenomena.

In order to clarify the definitions of the tabulated quantities we can demonstrate the fundamental relationships by means of the following diagrams and derivations. Refer to Figs. 1, 2 and 3. Assume a completely general source, A_s, of any size, shape or surface having any brightness pattern. Also assume a completely general receiver, A_r, having any size, shape or surface and located in space so that radiation can travel from the source to the receiver. We can then take any element of the source, dA_s, and any element of the receiver, dA_r, and examine the conditions for energy transfer between them. After the conditions of energy transfer between these elements are set up we can then integrate over the entire source and over the receiver to determine the total energy transfer. In the sketches, Figs. 1, 2 and 3:

D = distance between element of source and element of receiver,
α = angle between direction, D, and normal at source,
β = angle between direction, D, and normal at receiver,
ω = solid angle of receiver from a point on the source,
Ω = solid angle of source from a point on the receiver,
A_s = area of source,
A_r = area of receiver,
F = luminous flux emitted by the source,
E_p = illumination at point, p,
I_α = intensity of the source in direction, D, at angle, α,
B = brightness of element at source in the direction, D.

Light: For the purpose of illuminating engineering, light (luminous energy) is radiant energy evaluated according to the luminosity function. This is a defined mathematical function relating radiant energy and visual response.

Flux: The quantity, F, luminous flux, is defined as the rate of flow of light (luminous energy).

Flux Density: The quantities, E_p, I_α, and B, are derived quantities based upon *luminous flux per unit area* for, E_p; or *per unit solid angle* for, I_α; and *per unit area per unit solid angle* for, B, as will be brought out in the following paragraphs.

Illumination: If we consider first the flux *arriving* at the receiver in the region of point, P, (see Fig. 1) from the source, A_s, we have the flux on dA_r, which gives a surface density of the flux *arriving* at the receiver,

$$E_p = \frac{dF}{dA_r} \qquad \text{(flux per unit area)} \qquad (1)$$

This is given the name, Illumination, and symbol, E. (Note that the concept includes all of the flux *arriving* at the receiver without regard to direction or size of the source.)

Luminous Emittance: If we consider next the flux *leaving* the source, A_s, then at any element of area, dA_s, we have a surface density of the flux *leaving* the source,

$$L = \frac{dF}{dA_s} \qquad \text{(flux per unit area)} \qquad (2)$$

This is given the name, Luminous Emittance, and symbol, L. (Note that there is nothing to specify the direction or distribution of the flux *leaving* the area.)

The concepts of illumination, E, and luminous emittance, L, deal entirely with the total flux per unit area.

Intensity: Next let us consider the flux leaving the source in the general direction, D. Each small element of the source will radiate flux into space in straight lines and will fill a solid angle surrounding each element. There will be, therefore, a solid angle flux density associated with each unit solid angle into which each element of the source is radiating. Thus we have the quantity,

$$\frac{d^2F}{dA_s\, d\omega}$$

When integrated with respect to area only over the total projected area of the source, this becomes the total flux within a small solid angle in the direction, D, so we then have

$$I_\alpha = \frac{dF}{d\omega} \qquad \text{(flux per unit solid angle)} \qquad (3)$$

This term is given the name, Intensity, and symbol, I.

Intensity means the flux per solid angle radiating into space from the complete source. It is somewhat similar to the term pressure in a hydraulic system or voltage in an electrical system. As an analogy one can think of a water hose with an adjustable nozzle in which the water flow may be changed from a wide angle spray of low intensity to a small angle jet of high intensity. An adjustable focus flashlight is a corresponding lighting example. A given amount of light flux may be spread in a wide beam of low intensity or a narrow beam of high intensity. Thus, for any given rate of flow of light the intensity of light flux will change depending upon the solid angle within which the light flux in confined.

The intensity, I_α, relates to the total source and implies that the solid angle, ω, from any point on

the source to the receiver and the flux within this solid angle is essentially constant for all elements of the source. This condition will be met for most sources provided the distance between the source and receiver is large compared to the size of the source.

The usual form for expressing the intensity relationship is

$$I_{\alpha} = \lim_{D \to \infty} E D^2 \quad \text{(The inverse square law)} \quad (4)$$

This expression is another way of stating that the intensity is a property of the complete source and is constant provided that the distance, D, is sufficiently large. The units for this equation check the previous definitions and give flux per solid angle, as may be noted by dimensional analysis:

$$\frac{\text{flux}}{\text{solid angle}} = \frac{\text{flux}}{\text{area of receiver}} \times (\text{distance})^2$$

$$= \frac{\text{flux}}{\dfrac{\text{area of rec.}}{(\text{distance})^2}} = \frac{\text{flux}}{\text{solid angle}}$$

Brightness: Now we can set up the complete general expression relating all the components and indicate what the "brightness" quantity is in terms of purely physical entities. Refer to Figs. 1 and 2.

Take any small element of the source, dA_s. If small enough it will be a plane with its normal at angle, α, to direction, D. Along the direction, D, there will be a small solid angle, d_{ω}, containing flux radiating toward the area, dA_s, on the receiver at the point, P. Therefore, there will be an element of intensity, dI_{α}, in the direction, D.

To start with we have the relationship given in equation (4) which is known as the inverse square law of radiation and is based upon the straight line radiation of energy and a nonabsorbing and nonscattering medium. So we can say that the element of intensity, dI_{α}, will develop an illumination at the point, P, on the receiver plane, according to the relationship:

$$dE_p = \frac{dI_{\alpha}}{D^2} \cos\beta \quad \text{(or solving for)} \quad dI_{\alpha} = \frac{dE_p D^2}{\cos\beta} \quad (5)$$

where the normal to the receiver plane is at an angle, β, to the direction, D. The distance is always large compared to the small element of area so the relationship is rigorously true. Now, if we consider the element of intensity, dI_{α}, as originating from the small element of area, $dA_s \cos\alpha$, normal to the direction, D, we can set up the flux density relationship:

$$\frac{dI_{\alpha}}{dA_s \cos\alpha} = \frac{dE_p D^2}{dA_s \cos\alpha \cos\beta} \quad (6)$$

which is the same as the concept for *unit* intensity as deduced under the concept of Intensity, namely,

$$\frac{d^2F}{dA_s d_{\omega}} \propto \frac{1}{\cos\alpha}$$

For either side of equation (6) the dimensions are:

$$\frac{\text{flux}}{\text{area} \times \text{solid angle}}$$

Equation (6) is perfectly general and applies to any arrangement of source and receiver.

The left side of equation (6) can be interpreted directly as the intensity per unit of projected area (candles per square inch if these units are used). Thus we see that this is a fundamental property of the source in the direction, D, and is a characteristic of the particular source in the specified direction.

The same basic quantity may also be expressed in terms of the conditions at the receiver as shown by the right side of equation (6). Thus the basic quantity may be evaluated by the conditions at the source or at the receiver depending upon which is most convenient. In either case the same fundamental quantity is evaluated. It should be noted that the above relationships all assume that the radiant energy is not absorbed or scattered in travelling through the medium.

For convenience we should assign a symbol and name to the above quantity since it will be found to be very useful in evaluating sources, lighting equipment, luminous environments and all problems relating to luminous energy transfer. Because of long and accepted usage by both professional and lay persons, the name and symbol preferred for this quantity is *Photometric Brightness, B*.

There will be no confusion or misinterpretation of the term, Photometric Brightness, if the official I.E.S. definition adheres strictly to the relationship:

$$B = \frac{d^2F}{(dA_s \cos\alpha)\, d_{\omega}} = \frac{dI_{\alpha}}{dA_s \cos\alpha} = \frac{dE_p D^2}{dA_s \cos\alpha \cos\beta} \quad (7)$$

where the symbols have the meaning given in Figs. 1, 2, and 3.

This concept is for a physical quantity. The radiant energy has been modified by a mathematical function known as the "luminosity curve" but this does not introduce any subjective evaluation of the quantity. The luminosity curve has been

standardized and provides the conversion of radiant to luminous energy independent of a human observer.

Next, let us examine the above definition for photometric brightness and see what it means in terms of words, units, and practical applications.

In words, the simplest statement is that *Photometric Brightness is the luminous intensity per unit projected area of the source*. Photometric Brightness may also be described more basically at the source as the *luminous flux per unit solid angle per unit projected area*.

But some sources, such as the sky or a luminous vapor, do not have a definite surface, and, therefore, must be specified by the conditions at the receiver. By examination of the right side of the above defining equation we note also that the photometric brightness of any source may be defined at the receiver as *the luminous flux per unit projected area per unit solid angle*. The latter statement may not be immediately apparent but will be evident when the expression,

$$B = \frac{dE_p D^2}{dA_s \cos\alpha \cos\beta} \tag{8}$$

is considered as being made up of two parts:

$$B = \frac{dE_p}{\cos\beta} \times \frac{1}{\frac{dA_s \cos\alpha}{D^2}} \tag{9}$$

Since

$$\frac{dA_s \cos\alpha}{D^2}$$

is the solid angle of the element at the source as measured at the receiver, equation (9) has the following dimensions:

$$B = \frac{\text{flux}}{\text{unit area (at receiver)}} \times \frac{1}{\text{solid angle (at receiver)}} \tag{10}$$

The units of photometric brightness are, therefore, luminous flux per unit area per unit solid angle. Any system of units may be used to describe the quantity such as lumens/inch^2 $\times$ steradian, or candles/inch^2, candles/ft^2, candles/cm^2, or candles/m^2, but only terms which have these basic dimensions may be considered as photometric brightness terms. The Lambert system is discussed later.

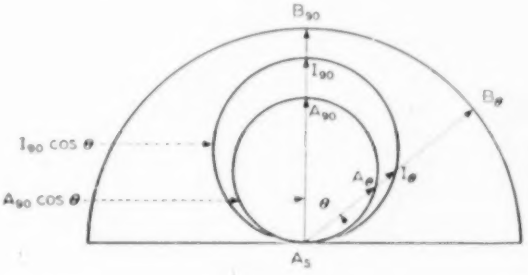
In practical application the above definition of photometric brightness fits exactly into the two situations in which photometric brightness is used: namely, the specification of the directional radiation characteristics of a source, or the appraisal of a source or an environment from a designated station. There is always a direction or line of sight involved. There is always a receiver — it may be an eye, a photocell, or some other material — and of course, always a source. The important quantity is the amount of luminous flux from an element on the source that arrives at the receiver.

It is not important, insofar as this quantity is concerned, to know the amount of flux radiated by the source in any other direction. The above definition ties photometric brightness down to exactly the desired quantity: (1) the luminous flux per unit area leaving the source per unit solid angle in a given direction or (2) the luminous flux per unit area arriving at a receiver per unit solid angle in a given direction.

The Lambert System

The above concept seems to be straightforward and clear and has been in general use for many years. There would not be any need for this review except for one *special case* that arises when certain limits are placed on the general expression. If the assumption is made that the *intensity distribution from each element of area of the source has a cosine distribution* ($I_\theta = I_{90} \cos\theta$), then the general expression reduces to a very simple relationship, and eliminates the need for complicated integration.

But the consequences of this assumption are very important and should be appreciated by everyone concerned with illuminating engineering. For example, consider an element of a surface having such a cosine radiation distribution:



We have: $$I_\theta = I_{90} \cos\theta \tag{11}$$

And $$\text{Projected Area}_\theta = \text{Area}_{90} \cos\theta \tag{12}$$

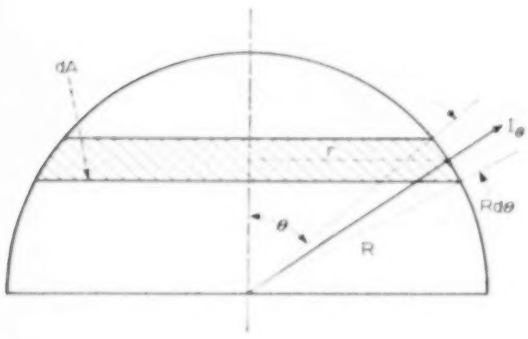
Also $$B = \frac{I_\theta}{\text{Projected Area}_\theta} = \frac{(I_{90}) \cos\theta}{(\text{Area}_{90}) \cos\theta} \tag{13}$$

So $$B = \text{Constant} \tag{14}$$

A cosine distribution of intensity is the equivalent of saying that the radiation is perfectly diffuse and that the photometric brightness is uniform in all directions from the element.

Now consider the total luminous flux radiated from the same element of area. We can easily determine the total flux radiated by considering the element enclosed by a hemisphere. All of the flux leaving the element will reach the hemisphere and will be equal to the illumination (flux/area) times the area of the hemisphere, so

$$F = \int_{\text{surface of hemisphere}} E\,dA \tag{15}$$



The illumination on the surface of the hemisphere is

$$E = \frac{I_\theta}{R^2} = \frac{I_{90} \cos \theta}{R^2} \tag{16}$$

The differential area on the surface of the hemisphere is

$$dA = 2\pi r \times R\,d\theta \quad \text{and} \quad r = R \sin \theta, \quad \text{so}$$

$$dA = 2\pi R \sin \theta \times R\,d\theta \tag{17}$$

Then

$$F = \int_0^{90} \frac{I_{90} \cos \theta}{R^2} \times 2\pi R \sin \theta \times R\,d\theta \tag{18}$$

or

$$F = 2\pi I_{90} \int_0^{\frac{\pi}{2}} \sin \theta \cos \theta\,d\theta \tag{19}$$

$$F = 2\pi I_{90} \left[\tfrac{1}{2} \sin^2 \theta \right]_0^{\frac{\pi}{2}} \tag{20}$$

therefore

$$F = \pi I_{90} \tag{21}$$

Which means that the total flux from a surface having a cosine distribution is π times the normal intensity. This is a most convenient relationship. Also if both sides of the equation are divided by the area of the element we have

$$\frac{F}{A_{90}} = \frac{\pi I_{90}}{A_{90}} = \pi B = L \tag{22}$$

Thus we note that π times the photometric brightness gives the total flux per unit area *provided the intensity distribution is a cosine function.*

Note that the units, flux per unit area, do not imply a direction but only the *total* flux per unit area radiated to space; therefore, the only condition under which the total flux per unit area is equal to π times the photometric brightness is the specific case where the photometric brightness is constant in all directions. For any actual source this is never exactly true.

Nevertheless, there are many instances in which the photometric brightness is almost constant and the above conditions are approximately true so it is oftentimes convenient to make the assumption that the radiation is perfectly diffuse. If such is the case, then

$$\pi B = L \quad \text{(luminous emittance)}$$

This is the basis for the Lambert System in which lumens/unit area are used as brightness units.

It has thus become common practice and convenient to consider πB as the brightness term. This is only strictly true for the case of the cosine distribution radiator. Names have been assigned this term, such as, footlambert, lambert and millilambert, depending upon the units employed. These are not photometric brightness terms in the foregoing sense, but are actually measures of luminous emittance.

The footlambert is the unit of luminous emittance equal to one lumen per square foot. Footlamberts are commonly used as a measure of photometric brightness in one of three senses:

(1) For sources that have *uniform photometric brightness* in all directions the luminous emittance is equal to π times the photometric brightness. Therefore, for the conditions of this paragraph the "uniform brightness" in footlamberts (lumens/ft^2) is equal to π times the photometric brightness in candles/ft^2.

(2) For sources that *do not have uniform photometric brightness* in all directions, but for which an average photometric brightness in all directions is desired, the actual luminous emittance is assumed to have a cosine distribution of such a magnitude that it will emit the same number of lumens per unit area as the actual source. Therefore, for the conditions of this paragraph the "average brightness" in footlamberts (lumens/ft^2) is π times the *average* photometric brightness in candles/ft^2.

This concept of *average* brightness is quite commonly applied to interior lighted surfaces where interreflections cause the luminous emittance to be quite diffuse. The

TABLE I.—Basic Quantities and Concepts Used in Illuminating Engineering.

05. Photometric

Present ASA Class	Name	Symbol	Defining Equation	Typical Units
05.005	Light	Q		
05.055	Quantity of Light	Q	$Q = \int F\,dt$	lumen × sec lumen × hrs
05.061	Light Density (volumetric)	q	$q = \frac{dQ}{dV}$	$\frac{\text{lumens} \times \text{sec}}{\text{cm}^3}$ $\frac{\text{lumens} \times \text{hr}}{\text{cm}^3}$
05.010	Luminous Flux	F	$F = \frac{dQ}{dt}$	lumens lightwatts

Luminous Flux Density (05.016)

A. *Flux density at a surface*

1. *ARRIVING* at a surface

05.035	Illumination	E	$E = \frac{dF}{dA_r}$	$\frac{\text{lumens}}{\text{ft}^2}$ (or ft candle) $\frac{\text{lumens}}{\text{m}^2}$ (or lux)

2. *LEAVING* a surface

None[1]	Luminous Emittance	L	$L = \frac{dF}{dA_s}$	$\frac{\text{lumens}}{\text{ft}^2}$ $\frac{\text{lumens}}{\text{cm}^2}$

B. *Flux density in a solid angle*

1. For the *total* source

05.020 05.025 05.030	Luminous Intensity	I	$I = \frac{dF}{d\omega}$	$\frac{\text{lumens}}{\text{steradian}}$ or (candles) (candlepower) (candelas)

also $I = \lim_{D \to \infty} ED^2$

2. For a *unit element* of the source

05.065 05.070 05.075	Photographic Brightness Alternate (luminance)	B

There are several forms for the defining equation:

General	a.	$B = \frac{d^2F \times D^2}{(dA_1 \cos\beta_1) \times (dA_2 \cos\alpha)}$
In terms of the source	b.	$B = \frac{d^2F}{d\omega dA_s \cos\alpha}$
In terms of the source	c.	$B = \frac{dI}{dA_s \cos\alpha}$
In terms of the receiver	d.	$B = \frac{dE_r \times D^2}{dA_r \cos\alpha \cos\beta}$
In terms of the receiver	e.	$B = \frac{dE_r}{d\Omega \times \cos\beta}$

The quantity has the dimensions of

$$\frac{\text{luminous flux}}{\text{unit area} \times \text{unit solid angle}}$$

or

$$\frac{\text{lumens}}{\text{ft}^2 \times \text{steradian}} = \text{candles/ft}^2$$

or

$$\frac{\text{lumens}}{\text{in}^2 \times \text{steradian}} = \text{candles/in}^2$$

or

$$\frac{\text{lumens}}{\text{m}^2 \times \text{steradian}} = \frac{\text{candelas}}{\text{m}^2} \text{ (nit)}$$

10. Radiometric

Present ASA Class	Name	Symbol	Defining Equation	Typical Units
10.005	Radiant Energy	U		
None	Quantity of Radiant Energy	U	$U = \int P\,dt$	ergs watt × sec calories Btu
10.020	Radiant Energy Density (volumetric)	u	$u = \frac{dU}{dV}$	$\frac{\text{ergs}}{\text{cm}^3}$ $\frac{\text{Btu}}{\text{ft}^3}$
10.015	Radiant Power (Radiant flux)	P	$P = \frac{dU}{dt}$	$\frac{\text{ergs}}{\text{sec}}$ watts $\frac{\text{Btu}}{\text{hr}}$

Radiant Power Density (10.025)

A. *Power density at a surface*

1. *ARRIVING* at a surface

None[2]	Irradiation (irradiance) (iradiancy)	H	$H = \frac{dP}{dA_r}$	$\frac{\text{watts}}{\text{cm}^2}$ $\frac{\text{Btu}}{\text{hr} \times \text{ft}^2}$

2. *LEAVING* a surface

None[2]	Radiant Emittance	W	$W = \frac{dP}{dA_s}$	$\frac{\text{watts}}{\text{cm}^2}$ $\frac{\text{Btu}}{\text{hr} \times \text{ft}^2}$

B. *Power density in a solid angle*

1. For the *total* source

10.030	Radiant Intensity	J	$J = \frac{dP}{d\omega}$	$\frac{\text{watts}}{\text{steradian}}$

also $J = \lim_{D \to \infty} HD^2$

2. For a *unit element* of the source

10.040	Radiance Alternates (unit intensity) (surface intensity) (steradiancy)	N

There are several forms for the defining equation:

General	a.	$N = \frac{d^2P \times D^2}{(dA_1 \cos\beta_1) \times (dA_2 \cos\alpha)}$
In terms of the source	b.	$N = \frac{d^2P}{d\omega dA_s \cos\alpha}$
In terms of the source	c.	$N = \frac{dJ}{dA_s \cos\alpha}$
In terms of the receiver	d.	$N = \frac{dH_r \times D^2}{dA_r \cos\alpha \cos\beta}$
In terms of the receiver	e.	$N = \frac{dH_r}{d\Omega \times \cos\beta}$

The quantity has the dimensions of

$$\frac{\text{watts}}{\text{unit area} \times \text{unit solid angle}}$$

or

$$\frac{\text{watts}}{\text{ft}^2 \times \text{steradian}}$$

or

$$\frac{\text{watts}}{\text{in}^2 \times \text{steradian}}$$

or

$$\frac{\text{watts}}{\text{m}^2 \times \text{steradian}}$$

1. Mentioned in 05.016

2. Mentioned in 10.025

concept of average brightness is useful only when the photometric brightness is reasonably uniform throughout a very wide angle of observation and over a large area of the surface considered. It has the advantage that it can be readily computed for reflecting surfaces by multiplying the incident luminous flux density (illumination) by the luminous reflectance of the surface. For a transmitting body it can be computed by multiplying the incident luminous flux density (illumination) by the luminous transmittance of the body. In practice the procedure is to measure the actual luminous emittance of a source by an integrating process such as a sphere photometer and designate the lumens/ft² as footlamberts.

(3). For sources that *do not have uniform photometric brightness* in all directions but for which the actual photometric brightness is known in a particular direction, the *equivalent* luminous emittance is determined for a source having the same actual photometric brightness and an assumed cosine distribution of such a magnitude that the *equivalent* luminous emittance is π times the actual photometric brightness. Therefore, for the conditions of this paragraph, the "equivalent brightness" in footlamberts (lumens/ft²) is π times the *actual* photometric brightness in candles/ft².

This method of specifying brightness is equivalent to stating the number of lumens which would be emitted if the surface were replaced by a perfectly diffusing surface with a photometric brightness in all directions within the hemisphere equal to the photometric brightness of the actual surface in the direction specified. In practice no surface follows exactly the cosine formula of emission; hence the photometric brightness is not uniform but varies with the angle from which it is viewed.

In practice this procedure is used for specifying the brightness of such surfaces as roadways, television screens, glass brick, etc. It should be noted that the brightness in footlamberts for such a surface implies a direction of viewing and that the *equivalent* luminous emittance (in footlamberts) does not specify the *actual* luminous emittance (lumens/ft²).

The footlambert is a widely used term and is not to be deprecated, but should be interpreted in the proper sense as it relates to uniform, average or equivalent photometric brightness.

The lambert is a unit of luminous emittance equal to one lumen per square centimeter. It is used as a measure of uniform, average or equivalent photometric brightness in one of three senses exactly as described for the footlambert.

The millilambert is a unit of luminous emittance equal to one millilumen per square centimeter. It is 1/1000 of a lambert.

There will, no doubt, be continued usage of the terms footlambert (lumens/ft²), lambert (lumens/cm²) and millilambert (millilumens/cm²) as modified brightness terms.

The official nomenclature should properly define these terms and should indicate them by a double name such as *uniform brightness*, *average brightness*, or *equivalent brightness*.

For many purposes the adjective, photometric or other, could be dropped, but insofar as the official nomenclature is concerned it is very necessary to have the diffused and the directional brightness quantities separated so that all the terms will check mathematically, dimensionally and logically.

It is recommended that the name "Photometric Brightness," with symbol, "*B*" be retained by the I.E.S. as the official designation for the basic brightness quantity having directional properties and the units of flux per unit area per unit solid angle and that the Lambert concept of a diffused source be shown properly under the luminous emittance quantities.

The complete list of basic quantities and concepts for illuminating engineering, arranged according to the system herein proposed, is given in Table I.

I.E.S. National Technical Conference

As everyone knows, the I.E.S. National Technical Conference is being held at the Hotel Commodore, New York City, September 14 to 17. Advance registration blanks have now been mailed from the Headquarters Office to all I.E.S. members, and early return of these blanks is to everyone's advantage. So make your plans definite now to attend the New York Conference with friends and family. Registration blanks should be returned to the I.E.S. Headquarters Office, 1860 Broadway, New York 23, N. Y.

INSTALLATION AT ALLEGHENY-LUDLUM STEEL CORPORATION, FERNDALE, MICHIGAN.

Lighting a Machine Shop

LIGHTING OBJECTIVE: To provide a high level of shadow-free illumination, to permit machines to be reoriented in any direction, and wide high lights on micrometers and dials for maximum visibility.

GENERAL INFORMATION: This machine shop measures 40 by 80 feet with a 14-foot ceiling. Surfaces are finished as indicated below:

ceiling	green tint	75% RF
walls	light green	65% RF
	yellow	70% RF
floor	gray cement	25% RF
machines	dark green	20% RF

INSTALLATION: Seventy-four Curtis No. 3526-CLH luminaires, each containing two 85-watt cool white fluorescent lamps mounted 10 feet above the floor spaced in a grid pattern as indicated in Fig. 2, provide an average illumination level of 90 footcandles. The upward component (30% of total output) from these units reduces their contrast with the ceiling; the luminaire design minimizes dirt accumulation on the reflecting surfaces.

(over)

A.I.A. File No. 31

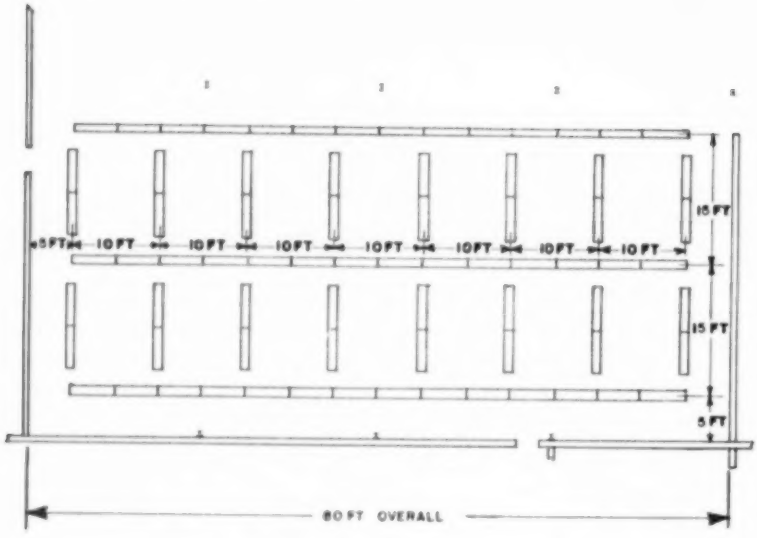


Figure 2. Plan view.

Brightnesses after 500 burning hours were as follows:

ceiling	33 ft L
yellow wall	19 ft L
green wall	18 ft L
floor	20 ft L
machines	6 ft L
luminaire	
inside surface	
crosswise at 10°	300 ft L
crosswise at 25°	360 ft L
crosswise at 30°	450 ft L
lengthwise at 20°	400 ft. L
outside surface	
crosswise at 25°	15 ft L

This room was used as a model for relighting the rest of the plant.

Lighting designed by L. E. Mueller and Harold Howe of the Detroit Edison Company; lighting equipment supplied by Jack Jones, General Electric Supply Company, Detroit.

Lighting data submitted by P. S. Schmidt, General Electric Company, and L. E. Mueller, Detroit Edison Company, as an illustration of good lighting practice and to aid in the design of similar installations.

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Relation Of Critical Fusion Frequency To Fatigue In Reading

By T. A. RYAN
M. E. BITTERMAN
C. L. COTTRELL

WHEN a flashing light gradually increases its rate of flashing we reach a point where the observer no longer sees the light as flashing or flickering. The speed at which the perception changes from "flickering light" to "continuous light" is known as the *critical fusion frequency* (CFF). This frequency varies under various physical conditions and also from person to person. In addition it varies in the same person from time to time, even when the external conditions, such as surround brightness, area of the target, etc., are held constant.

Several investigators, especially Simonson, have found that the CFF is depressed by fatigue, or at least by long continued difficult mental or visual work. This would suggest that measurements of CFF before and after a task would provide an indicator of the degree of fatigue produced by the task. If this were so, it might even provide a method for evaluating conditions of illumination for various visual tasks.

Unfortunately, there were also divergent results which cast doubt upon the validity of change in CFF as an indicator of fatigue. Because of this state of affairs, it seemed that further efforts to evaluate the CFF index should be made, and the writers were fortunate in securing the support of the I.E.S. Research Fund in purchasing equipment and providing assistance for the project.

To sketch the previous research briefly, Snell had reported some years ago that CFF was depressed by exposure to flickering lights.[1] Later, Simonson proposed the theory that CFF was a function of general central nervous system fatigue, rather than of specific fatigue of the visual mechanisms.[2] He found CFF uniformly depressed after a day's work in offices or laboratories. MacFarland and others, however, could not duplicate this result even in subjects who had spent a whole day grading handwritten examinations.[3] There was an important difference in method in the two studies, however. Simonson worked directly with the frequency threshold by varying the rate of flashing in the stimulus. MacFarland had plotted the threshold as a function of the brightness of the flickering stimulus at fixed frequencies. Although the two thresholds are interrelated by the well-known frequency-brightness threshold function, the task for the subject is different, and fatigue may not necessarily have the same effect upon the two kinds of threshold.

Subsequently, Simonson and Brozek have employed CFF measurements for a visual task under varying illumination. The task was the detection of very small printed letters distributed at random on a moving tape so that they appeared unexpectedly through a small window. Thus the task was more difficult, visually, than reading. Using this method, they found significant changes in the CFF index after two hours of work.[4] The amount of change was not significantly different at different levels of illumination, ranging from two to 300 footcandles. On the other hand, the amount of change was affected by changes in spectral distribution of the illumination, produced by different lamps.[5]

In addition to studies of CFF as an indicator of fatigue, there were other hints that the index was related somehow to the general condition of the organism. The effects of brain injury, of various diseases, and of drugs tended to suggest this point of view, and supported the position that CFF is not only related to the state of the ocular mechanisms, but rather to the state of the nervous system.

For all of these reasons, the writers decided that further studies of the relation between CFF and the after effects of visual work were needed. We were also convinced that an index of fatigue should be sensitive enough to reflect the effects of normal tasks such as reading, if it is to be useful in solving such problems as the optimal level of illumination for offices and classrooms. Simonson and Brozek's results have little bearing upon such problems

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because of the extremely fine visual discriminations which were involved in their task. Instead, their results probably have more to do with certain kinds of industrial inspection than they do with ordinary reading. Consequently, we decided to test the relation between prolonged reading and CFF under varying conditions of illumination.

Methods and Results

Apparatus: The subjects sat at a table set before a large hemispherical surround. Table and surround were painted flat white and the entire working enclosure would be illuminated diffusely by incandescent lamps to any brightness level up to 1000 footlamberts. The lamps were powered by a d-c line. On the horizontal line of sight a circular opening of two degrees was cut in the surround. Behind this opening a magnesium-oxide screen was set at a 45-degree angle, and it was upon this screen that the flickering light could be projected. Variable frequency, square wave, black and white flicker was produced by intercepting the real image of a small-area light source with a rotating sector disc. The on and off times were of equal duration.

The critical fusion frequency was measured by increasing the speed of revolution of the sector disc until the subject signalled that he no longer saw flicker. In the later experiments the rate of increase of the speed was controlled automatically by a motor driven circuit (designed and built by Tom Cornsweet, one of our assistants). In the earlier experiments, the changes were made manually, although the experimenter kept the rate of change as constant as he could. In either case, the rate at which fusion occurred was read from a tachometer-driven voltmeter. These readings were accurate to about 1/10 cycle/sec. In all experiments except 1c, the base level was constant for any given subject and at a level determined from preliminary practice tests. When the automatic controls were used the acceleration of the flicker was also constant for a given subject.

1. Methodological Experiments

1a.—Effect of surround brightness upon CFF.—Since we wished to test for fusion frequencies under different illuminations it was important to choose as our target brightness the one which would be least affected by the surrounding conditions of test. We therefore determined the fusion frequencies for an effective target brightness of 1, 7 and 50 footlamberts and for surround brightness of 1, 7, 50 and 350 footlamberts. Each target brightness was paired with each surround condition. Suitable controls for adaptation and practice effects were used but will not be reported in detail here. A total of 144 determinations of critical fusion frequency for three subjects were secured.

TABLE I.—Effect of Surround Brightness upon Fusion Frequency. Mean Fusion Frequencies for Each Condition.

Target Brightness (Footlamberts)	Surround Brightness (Footlamberts) 1	7	50	350
1	29.1	26.8	22.4	0
7	34.9	35.8	32.2	28.2
50	39.6	39.7	39.8	37.8

Results are shown in Table I. It is evident that, of the available range of target brightnesses, the 50-footlambert level produces the most stable thresholds under conditions of varying surround brightnesses.

1b.—Effects of adaptation.—The purpose of this experiment was to find out whether CFF changed systematically as the subject adapted to the general illumination conditions. The method was to take readings at the beginning and end of a five-minute period of adaptation to a given level of illumination, then switch to another level, again taking the readings immediately after the change and at the end of five minutes.

With the target at 11 footlamberts, the general illumination of the surround was changed at random from one to another of three levels. These were such that the brightness of the surround was either 0, 2, or 50 footlamberts.

Results. We could find no systematic effects of adaptation upon the level of the critical frequency. Trends in the various periods were inconsistent with each other and the changes were as great between individual readings in a test run as they were over the adaptation period.

1c.—Effects of base level and acceleration upon CFF.—In terms of our actual working sequence, this experiment was performed last, after the experiments upon the effects of prolonged work. It was undertaken to provide information to be used in the design of future experiments. We wished to know the influence of the starting rate (base level) of the flicker and also of the rate of increase of the flicker upon the level chosen by the subject as the fusion frequency. In the other experiments described in this report these factors had been held nearly constant for each subject in any one experiment. We wished to know how important this precaution was, and also to consider the possibility of other ways of handling these variables.

In its essentials the procedure of this experiment consisted of making a group of ten threshold readings at a given setting of the apparatus, that is, a given combination of base level and acceleration.

TABLE II.—Relation of CFF to Acceleration at Selected Base Levels.

Base Level	Low Acceleration .52 to 1.04 cycles per sec. per sec.	Mean CFF (cycles/sec.) Med. Acceleration 1.08 to 1.52 cycles	High Acceleration 1.56 to 2.00 cycles
24 cycles/sec.	35.87	37.05	37.28
26 cycles/sec.	36.06	37.42	37.07
30 cycles/sec	37.17	38.36	38.62

The settings were then changed and another group of ten readings recorded. The order of presentation of the various combinations of base level and acceleration was haphazard. The base levels ranged from 18 to 30 cycles per second. Accelerations ranged from 0.5 cycles/sec./sec. to 2.0 cycles/sec./sec.

Results. Average CFF for three different base levels and for three ranges of acceleration are shown in Table II. These are three of the base levels for which we obtained the largest number of readings over the widest range of accelerations. This analysis is designed primarily to show the effect of acceleration for a constant base level. Results for the high accelerations are less reliable than those for the other two ranges, because there were fewer readings at the high accelerations.

In Table II it will be noted that an increase in acceleration tends to increase the threshold value of CFF. This table also illustrates the fact that thresholds tend to increase with the base level from which the observation starts. Starting the flickering stimulus at a high rate tends to produce a report of fusion at a higher rate. A more detailed picture of the relationship to base level can be seen in Table III, where results for all accelerations are averaged together.

The results for acceleration are consistent with the hypothesis that there is a lag between the time the stimulus actually reaches threshold and the time when the subject signals that he sees fusion. A delay in signalling with the higher accelerations means more of an increase in rate of stimulus before the signal is given. The reason for the effect of base level is not so clear. One possibility is a tendency to wait until the appearance of the stimulus has changed by a certain amount before signalling. Thus when the base level is high, the subject delays his response until the actual rate is high.

TABLE III.—Relation of Base Level to CFF.

Base level (cycles per second)	Mean CFF (all accelerations) (cycles per second)	No. of observations
20	34.37	12
22	36.04	53
24	36.76	51
26	36.83	51
28	38.06	41
30	38.25	38

The results do not indicate that the subject merely waits for a fixed time interval before signalling. Such a tendency could produce the general direction of the results reported above, both for acceleration and for base level. Another method of analysis, however, makes such an explanation doubtful. There is a wide spread of times — from four to 22 seconds — in various settings. For a given base level, the changes in acceleration are so large that a much greater change in threshold would result if the time were kept constant. In the same way, for constant acceleration a given change in base level would produce the same amount of change in threshold if time were constant. Yet in Table III a change of 10 units in base level produces less than four units change in CFF.

Implications. It is thus evident that the starting or base levels and the acceleration are factors which must be carefully controlled in studies of flicker thresholds. Probably the best method for fatigue studies is to use a constant acceleration in the lower range, say .6 cycles per sec. per sec. and to vary the base levels haphazardly from trial to trial in such a way that each base level appears the same number of times in the before and after tests.

Inasmuch as most of the previous work upon flicker as a fatigue test has used a method in which the subject varies the stimulus himself, the acceleration was probably highly variable, and it is an open question what effect this would have upon the results. We need an extension of the present experiment in which the reliabilities of thresholds obtained by our method and by the previous method are compared.

2. *Effects of Prolonged Visual Work upon CFF*

2a.—Effects of illumination level during work: flicker tests made in same illumination as the work. The task of the subjects was to read *Lorna Doone* in the Everyman's Edition. This was one of the books employed in the experiments of Carmichael and Dearborn and for which they developed interpolated comprehension tests of the multiple choice variety.[6] Test sheets were inserted into the book at various points and the subjects were instructed to take each test as it was come upon in the course of reading. Both the book and the tests were printed in black, 10-point, medium bold, Old Style type, set solid on dull paper. The reading periods were 3½ hours in length, the subjects being instructed to read continuously at the "natural rate" during that time, except when interruption for the

purpose of taking the comprehension tests or for making CFF measurements was necessary.

Three levels of illumination were employed—producing surround brightnesses of 2, 11 and 50 footlamberts. Each subject came to the laboratory for three experimental sessions, one on each of three experimental days. The session began at the same hour on each experimental day. All experimental days for a given subject fell within the same week, and the experimental days were always separated by a non-experimental day. Thus, for example, Subject No. 1 read from 2:00 to 5:30 p.m. on Monday, Wednesday, and Friday of the first week, and so forth. All possible illumination orders—six in all—were employed. Subject No. 1 read under 2 footlamberts on the first day, 11 footlamberts on the second day, and 50 footlamberts on the third day. For the second subject the order was 2 footlamberts on the first day, 50 footlamberts on the second day, and 11 footlamberts on the third day, and so forth. Two subjects were employed for each order, making a total of 12 subjects in all. Each subject began at the beginning of the book on the first day, and on successive days took up again at the point at which he had stopped the day before. Any inhomogeneities in the reading material tended to be balanced out by the systematic variation of illumination orders.

On the first experimental days the subject was given general instructions and practiced in the procedure of making CFF determinations until consistent readings were obtained. On each day a 15-minute period of adaptation to the prevailing illumination level and practice in fusion judgments was allowed, following which six CFF determinations were made. The subject then began to read, and six more CFF determinations were made at the end of each half-hour of work. For all CFF measurements, the effective brightness of the flickering target was 50 footlamberts. This high target brightness was employed in order to minimize variation in initial CFF level due to variation in surround brightness (See experiment 1a).

The experimental subjects, men and women, were drawn from undergraduate classes in psychology. Their vision was either normal or corrected to normal.

Results. The results of this experiment are presented in Table IV.

For each subject eight sets of flicker measurements were made in the course of work under each level of illumination. Two indices of change in CFF during each work session were computed: (1) the difference between the mean of the first four sets (24 readings in all) and the mean of the last four, and (2) the difference between the mean of the first two sets and the mean of the last two sets.

TABLE IV.—Experiment I. Mean Decrement in CFF Following 3½ Hours of Reading.

Index	2 ft-L	11 ft-L	50 ft-L
1st 24 readings—last 24 readings	1.25 cycles/sec.	0.93 cycles/sec.	−0.04 cycles/sec.
1st 12 readings—last 12 readings	2.08 cycles/sec.	0.88 cycles/sec.	0.75 cycles/sec.

There are two methods of determining the significance of these results. The first is concerned with the question of whether the differences are greater than could be expected because of the experimental errors involved in the technique. The second is concerned with whether these differences could be expected to occur in other samples of subjects.

From the first point of view both differences at 2 footlamberts are significant and the larger of the two differences for 11 footlamberts is significantly greater than could be expected from the experimental error. Both results at 50 footlamberts could be mere variations due to experimental error.

From the point of view of the sampling of individuals, this sample is not large enough to determine whether or not the results are significant. Some subjects showed decreases in flicker fusion rate after work and some showed increases in each of the conditions.

It is therefore clear that declines in fusion rate after reading are by no means universal. The question of what is the average tendency in the whole population requires the use of more subjects than we had here. Before extending the work, however, we decided to introduce other controls as described in experiment 2b. As an indication only, we present in Table V the distribution of the gains and losses in fusion rate, in terms of the numbers of subjects showing gains or losses in each condition.

It must be stressed that while the results in Table V are in the expected direction, according to current beliefs about the values of higher illuminations, the results could be accounted for on the basis of chance.

2b.—Effects of illumination level: flicker tests under varying conditions of illumination.—In de-

TABLE V.—Frequency of Gains and Losses in CFF Following Reading.

	Condition of work		
No. of subjects showing:	2 ft-L	11 ft-L	50 ft-L
Decreased CFF	9	8	6
Increased CFF	3	4	6

signing the first experiment we were disturbed by an important problem. The plan, it appeared to us, involved the use of not *one*, but *three* measures of fatigue — a different measure for each level of illumination employed. When the subject worked under 2 footlamberts, CFF was measured with a surround brightness of 2 footlamberts; when the subject worked under 11 footlamberts, CFF was measured with a surround brightness of 11 footlamberts; and so forth. It occurred to us, therefore, that any differential decline which appeared in experiment 2a might be a function, not of variation in working level of illumination, but of the different sensitivity of tests conducted at the different levels. We had considered the possibility of conducting all the CFF tests at the same surround brightness but such a procedure would have introduced a new variable — adaptation level — which might also influence the sensitivity of CFF to fatigue in spite of the results of experiment 1b. This variable, it should be noted, was not controlled in the illumination experiments of Brozek and Simonson.[7] We decided, therefore, to proceed with the first experiment as planned, and to depend on subsequent control experiments for a separation of the two factors confounded in its design.

In the second experiment, each of 32 subjects read for two 3½-hour periods under two conditions of illumination — 2 and 50 footlamberts. For 16 of the subjects a set of 10 CFF determinations was made at a surround brightness of 2 footlamberts before and after each reading period. The following procedure was employed. The subject was adapted for 15 minutes to the 2-footlambert level and CFF measurements were made. Then the subject began to read. If the working level scheduled for the period was 2 footlamberts, that level was maintained throughout the working period and the final CFF determinations. If work under 50 footlamberts was called for, the subject began work under 2, but in the next few minutes the level was gradually raised to 50. Work then continued at the high level for more than three hours, following which the illumination was lowered in stepwise fashion so that during the final 15 minutes the brightness was again 2 footlamberts. By the end of the 3½-hour working period the subject had had time in which to become adapted to the low level, and the final CFF determination could be immediately begun at this level. In both cases, therefore, the test conditions were the same, but in one case the bulk of the reading was done at the high level and in the other case at the low level. The second group of 16 subjects was treated in a comparable manner except that all tests were made at the higher surround brightness. Order effects were controlled for both groups.

TABLE VI.—Mean Decrease in CFF after 3½ Hours of Reading.

	(Cycles per second) Condition of test:		
Condition of reading:	2 ft-L	50 ft-L	Mean
2 footlamberts	0.21 cycles/sec.	−0.12*	.05
50 footlamberts	0.69	0.24	.47
Mean	0.45	0.06	.26

*Minus sign indicates an average rise in CFF.

TABLE VII.—Percentage of Subjects Showing Decreases in CFF after 3½ Hours of Reading.

	Condition of test:		
Condition of reading:	2 ft-L	50 ft-L	Mean
2 footlamberts	38 per cent*	38 per cent	38 per cent
50 footlamberts	81 "	63 "	72 "
Mean	59 "	50 "	54 "

*Percentage in each specific combination of conditions based upon 16 subjects.

Results: The results are shown in two forms in Tables VI and VII. Table VI shows the mean decrease in fusion frequency under each of the four conditions in cycles per second. Table VII shows the percentage of subjects who showed declines in CFF under each of the conditions. The mean differences shown in Table VI are very small and unreliable. This is because of the wide variations from subject to subject. Table VII gives an indication of the amount of variation from subject to subject.

It will be seen that, taking the experiment as a whole, only 54 per cent of the working periods showed declining CFF while the remainder showed *increases*. There are *fewer* declines under low illumination than under high illumination which is contrary to current beliefs about the value of high illumination and the belief that work under unfavorable conditions reduces the flicker threshold.

When the flicker test is made under the low brightness of the surround (2 footlamberts) there appears to be more decline in the threshold during work, although this difference is not great enough to rule out the possibility that it is due to chance. Even if it were significant, however, we should still have the contradiction that greater and more frequent decrements in CFF occur at the higher illumination level for reading.

2c.—Effects of glare during reading. — The results of the previous two experiments might be due to the fact that variations in illumination are not actually changing the difficulty of the visual task. That is, there may be no differences in effect between the various illuminations simply because,

due to adaptation, these differences are unimportant to the visual mechanism. We therefore decided to compare reading under conditions of glare with reading under better distributed illumination. No one questions the assumption that localized bright areas are uncomfortable and lead to visual fatigue. If, therefore, CFF is a satisfactory index of visual fatigue, it should reflect the effects of this uncomfortable condition.

The task of the subject was the same as that used in experiments 2a and 2b on the level of illumination. Each subject read for two periods, one under normal conditions previously described with the surround illuminated to 11 footlamberts. The other condition consisted of the addition of a bright light source just above the material to be read. The light source was a 25-watt bulb behind a plate of ground glass. The brightest spot was 1100 footlamberts. The ground glass was on the front of a box 4.5 inches beyond the material to be read and 6½ inches above the surface of the table. Half of the subjects received the glare in their first working period and half received it in their second period of work.

Although the glare source was not as bright as we could have used, we were hesitant to increase its brightness further because of the length of the reading period involved. If the glare had been too uncomfortable it might have led the subjects to stop work or refuse to continue. We were apparently too cautious in this respect, since only one subject complained that the glare was very tiring, and two stated that they preferred the glare condition. Ten subjects in all were used.

Results. The results are shown in Tables VIII and IX and show that there is a mean *increase* in CFF following work, both with and without the added glare. The increase is somewhat more in the non-glare condition, but the difference is not significant statistically. Table VIII presents the mean changes, while Table IX shows the number of subjects showing increases or decreases in CFF. Most subjects show the same trend as the mean, with even slightly *more* increases under glare conditions.

We therefore find no effect of glare upon CFF and we again find that the task does not produce a drop in CFF after 3½ hours of reading. Whether a more severe discomfort produced by a brighter glare source would produce declines in CFF is therefore a problem worth pursuing, but there was not time on this project to do so.

TABLE VIII.—Mean Change in CFF as a Function of Glare During Reading.

Condition	Mean Increase (cycles per second)
Normal	.65
Glare	.32

TABLE IX.—Number of Subjects Showing Increase or Decrease in CFF.

Condition	No. Showing Increase	No. Showing Decrease
Normal	7	3
Glare	8	2

Conclusions

There are two alternative hypotheses to account for the discrepancies between our results and those of previous experimenters who have used CFF as a measure of fatigue. (1) It is possible that the CFF decrement is sensitive only to severe degrees of fatigue and that our task was not sufficiently long or difficult enough to produce these effects. (2) Fatigue is a complex condition involving a number of more or less independent effects. In a visual task there are the general effects of doing a difficult job—maintaining attention at a high level, performing difficult calculations, etc. In addition there are the more specifically ocular effects which are usually called eye-strain, eye-fatigue, etc. In our case the non-visual aspects of the task were relatively easy, in that the subject had only to read relatively easy material. While the subject was tested upon what he had read, this still does not require a high level of strain for results. Even under poor lighting conditions the task is taxing only to the ocular mechanisms themselves, but is still relatively easy otherwise. The second hypothesis is, then, that the flicker threshold drops as a result of the general strain or stress in the task rather than as a result of the visual strains alone.

The second hypothesis would account for a number of facts, both results of our own experiments as well as those of others.

Other investigators who have reported consistent drops in CFF following work have been concerned with tasks involving general difficulty (*e.g.*, mental calculation) as well as specifically visual strain. Simonson and Brozek's studies of illumination level and of spectral composition of the illumination, in which significant changes were found, can be accounted for on this basis. The task was much more difficult visually (extremely small letters to be discriminated) and the task required constant attention. The primary task to be performed was visual and the attention called for in the task was attention to *visual* details. Thus changes in visual conditions made the whole task, the central aspects of the task, more difficult. In reading, on the other hand, the visual aspects are subsidiary. Difficulty

and interest are primarily matters of content rather than visual conditions.

Since these experiments were completed, Davis has performed an experiment upon the effects of mental work upon both visual and auditory flicker fusion.[8] He found that mental multiplication for two hours produced significant reductions in both visual and auditory flicker thresholds. If anything, the changes in the auditory thresholds were more reliable than those in the visual flicker thresholds. Here, then, is further evidence that CFF measures the general difficulty of the work performed, and that it is not dependent upon specifically visual conditions of work.

It may be asked why we did not use a task which was primarily visual, like that used by Brozek and Simonson, if our second hypothesis is considered acceptable. One reason is that this hypothesis was not formulated when we designed our experiments. More important, however, we still believe that a task which is not centrally visual is more appropriate to the problem. Most normal tasks in business, industry or the home are only secondarily visual, and reading is a widespread task.

The problem is to find whether there is a fatiguing effect of low illumination or other inadequacies of lighting for tasks like reading in which seeing is essential but not central to the task. To be useful, a measure of such a fatigue effect must be sensitive enough to show variations within the range of normal illuminations. If it shows effects only when the illumination drops to the point where the subject can barely see the material it is not a sensitive enough measure to answer the main questions which are being asked by illuminating engineers: namely, what are the *optimal* levels of illumination for a task like reading?

The fact is we do not now have a measure which is sufficiently sensitive to the effects of visual strain in the ordinary reading task. It may be that such a measure will never be found, since it is possible that the level of illumination is unimportant so long as it is above certain low minimal levels. Perhaps within these wide limits the adaptation of the visual mechanism adequately compensates for the variations in the physical conditions.

Since there is no way of positively proving this last contention, the only method open seems to be to examine every possible index of fatigue to determine whether it is sensitive enough to show any effects of varying illumination level. Our examination of CFF from this point of view does, we believe, eliminate the possibility that it will show any effects in reading of specifically visual factors over a wide range. In fact, we suggest that CFF does not reflect precisely the visual strain in the situation, but rather the general difficulty, stress, alertness, and concentration required by the task.

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Practice for Supplementary Lighting in Industry

The Recommended Practice for Supplementary Lighting, to be used with the recently published Industrial Lighting Standard, has just become available. This new 16-page report by the I.E.S. Sub-Committee on Supplementary Lighting will be extremely useful to anyone concerned with lighting an area or operation involving critical seeing in industrial plants.

The Practice deals primarily with the many critical seeing tasks involved in fabrication and inspection for manufacturing processes and recommends lighting to supplement general lighting systems. Various sub-titles of the report cover Analysis of Seeing Task; Supplementary Lighting Equipment; and Classification of Visual Tasks and Lighting Techniques. Tables give information in a form for easy reference.

Table III, for instance, classifies visual tasks and lighting techniques for each; Part I dealing with flat surfaces, Part II with three-dimensional objects. The table gives material and description of task involved; lighting requirements for each; suggests luminaire type and location. Other tables recommend brightness ratios and light reflectances for interior surfaces. Illustrations show a wide variety of properly lighted industrial operations.

Copies of the new Recommended Practice for Supplementary Lighting may be obtained from: Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y. Single copies, 50c; quantity prices on request.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

June Council Meets in New York— Summary of Action Taken

The final Council Meeting of the 1952-1953 Administration was held in New York, June 10. A very large representation of the full Council attended, including: Prof. E. M. Strong, President, presiding; Past Presidents S. G. Hibben and Walter Sturrock; Vice Presidents Duncan M. Jones and A. H. Manwaring; General Secretary C. C. Keller; Treasurer K. M. Reid; Directors: G. W. Beals, C. R. Long, N. D. Macdonald proxy for J. S. Schuchert, B. C. Cooper proxy for R. A. Palmer, J. F. Whitehead, F. C. Winkler; Regional Vice-Presidents: L. B. Paist, P. H. Hildebrand, F. P. Labey, G. J. Taylor, L. C. Twichell, M. J. Myers, Jr. proxy for W. E. Folsom, M. N. Waterman proxy for R. C. Paslay, W. F. Little proxy for L. A. Hobbs, L. H. Graves proxy for W. J. Lind; Executive Secretary A. D. Hinckley, Editor Ruby Redford, Advertising & Promotion Manager C. E. Ellis; Clarence J. Berry, R. F. Hartenstein, R. G. Slauer and S. R. Williams.

Council opened with a Resolution entered in the Minutes recognizing its loss in the recent death of Professor H. B. Dates, a past president of the Society, and stood for a minute's silence in respect.

Advance Planning

Following approval of Minutes, and a report on the Society's financial status, discussion was initiated on the report, by C. C. Keller, Chairman of the Advance Planning Committee, outlining their recommendations on future aims and plans.

Recommendation No. 1 concerned the formation of a committee to plan long-range fundamental research. Action of Council approved the recommendation in principle with suggestions that the committee be appointed to study the committee's scope and to report to Council before proceeding.

Recommendations Nos. 2 and 3 suggested combining solicitation of sustaining members' dues and research funds into a single annual solicitation, and recommended that sustaining dues be applied solely to research and other projects. Following discussion a motion to table this recommendation for further study was carried by a narrow margin of Council votes.

Recommendations Nos. 4, 5 and 6 would form a new Regional Conference Committee to be responsible nationally for all regional conferences; the formation of a Regional Papers Committee to review and approve all regional conference papers, and a plan for national financial underwriting of regional conferences. Action, following discussion, was to refer these suggestions to the Committee on Local Activities for study and report to Council.

Recomendation No. 7 would establish a Task Committee to study the headquarters operation with special reference to understudies for staff executives. Council approved this plan, suggesting such a committee be under the direction of the General Secretary, with the additional suggestion that such advisory personnel to the General Secretary could study this and all other operation problems.

Recommendation No. 8 suggested transportation expenses of officers to Council meetings and regional vice-presidents to each of their Sections and Chapters. This recommendation was referred to the Finance Committee for study and report.

Recommendation No. 9 would limit future I.E.S. Sections and Chapters to the U. S. and Canada and would reduce foreign members' dues. A motion to reduce dues for all members outside of the U. S. and Canada was carried, referring this recommendation to the Constitution Committee.

Recommendation No. 10 would direct the Publications Committee to publish all Transactions of the Society in a separate section of the publication, these Transactions to be also available in bound form on subscription. Council action referred this recommendation to the Publications Committee for study and report.

Recommendation No. 11 suggested a Society report on activities and progress to all sustaining members. Council recommended that the I.E.S. Dividends booklet or its equivalent be sent each year to all such members.

New Fellows

A recommendation of the Policy and Procedures Committee was approved, Modifying the procedure for the nomination of Fellows of I.E.S.

The Board of Fellows reported to Council on their study of recent nominations and recommended the election of 12 Members to Fellow Grade. Council accepted the report for letter ballot on these elections.

Local Activities

A report on the Society's local activities was presented by Chairman Duncan M. Jones, summarizing recommendations discussed by his committee at a meeting the previous day. These included suggestions for new Section and Chapter budgets, simplifying allowable expenses and recommendations with regard to the contest for "My Most Interesting Lighting Job." In connection with the latter local activity, he mentioned that 118 members entered this contest at the local level, with 30 regional entries. Nine regions will be represented with entries at the National Technical Conference.

He reported considerable interest in possible new Chapters in a number of locations, and mentioned especially the active Oklahoma Study Club formed recently.

Committee Reports

With favorable letter ballots reported by A. D. Hinckley, Council approved technical committee reports as follows:
Revision of 1948 Guide for Electrical Measurements of Fluorescent Lamps.
Recommended Practice for Residence Lighting, 1953.

Election of Officers

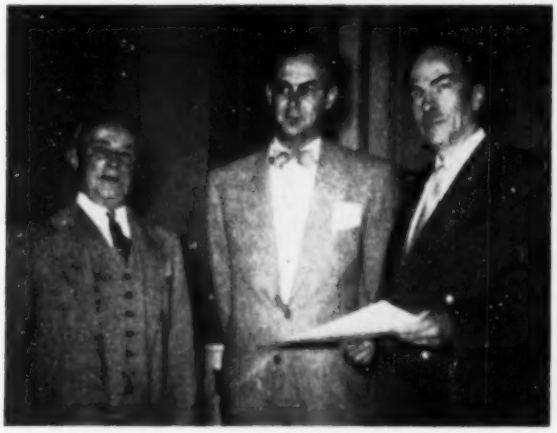
Mr. Hinckley read a report of the Board of Tellers on the members' ballots for national and section officers for 1953-1954, and balloting on Constitution changes. A complete list of officers elected is given in this issue of Telecast.

New Mid-West V P

The resignation of L. B. Paist as Regional Vice President of the Midwestern Region leaves a vacancy in this post, for one year of his unexpired term. Expressing his deep regret in this circumstance, Mr. Paist reported a meeting of the Regional Nominating Committee and their recommendation that Clarence Pederson

Here and There with I.E.S. Members

The St. Louis Section dinner dance, May 23, was its last meeting of this highly successful year. The dance, held in the Gold Room of the Jefferson Hotel, had a record attendance of 285, and was considered by many members as the finest meeting of a fine year.



At the April meeting of the Connecticut Section, Lt. Cmdr. Dean Farnsworth (right) was presented with the Certificate of Fellow Grade of the Society by G. W. (Shorty) Beals, Director of the Society (left). Connecticut Section Chairman Francis Clark looks on.

President's Night Dinner at the New Orleans Section meeting March 30, honoring President Strong, was held at La Louisiane Restaurant, Regional V-P R. C. Paslay also attended.

Certificate of appreciation was presented to Inter-Mountain Regional V-P Harold Rankin (center) by Carl Strain, Secretary of the Rocky Mountain Section (left). Section Chairman Ferman Bischofberger (right) also received a certificate of appreciation for his services.

President-Elect A. Homer Manwaring and Philadelphia Section Chairman T. W. Lauer hold the "One Footcandle" table prize which was presented to Mr. Manwaring at the Ladies' Night Meeting of the Section, April 13. Photo was taken by I.E.S. member Earle Hawkins.

of the Chicago Section be appointed for the remainder of his term. Acting on this recommendation, Council appointed Mr. Pederson Mid-Western Regional V-P for the remainder of the term.

MEMBERSHIP ELECTIONS

Delinquent members dropped for non-payment of dues were reported by Mr. Hinckley. He also reported, for the Board of Fellows, the election of 91 Associate Members, and 8 Student Members and their recommendation for the election, transfer, and/or reinstatement of 20 Members. The current membership statistics were:

September 30, 1953		June 10, 1953
7394	Total Membership	8134
34	Members Emeritus	33*
41	Fellows	58
5293	Associate Members	5834
1797	Members	1903
229	Student Members	306

*Includes 12 Fellows.

A report on the individual membership picture for this past year was outlined to Council by R. G. Slauer, Chairman of the Membership Committee. Mr. Slauer's report showed that membership now stands at its highest point in the Society's history, and noted that membership increase as of June 1 was 8.5 per cent as compared with 5.7 per cent at the same time last year. Paying tribute to the activity of local chairmen, Mr. Slauer suggested a five point program for future operation.

PUBLICATIONS

Duncan M. Jones, Chairman, reported action of the Publications Committee at its meeting June 9, indicating, among other items:

A second printing of the Handbook, Second Edition, will be available by January 1954.

They recommend that a new Handbook Committee be appointed, aiming at January 1957, for a Third Edition.

A color chart of recommended colors will be included in the reprint of Recommended Practice of Residence Lighting.

N.E.M.A. To Conduct Certified Relighting Program

Plans for the first national certified relighting program for commercial and industrial premises have been approved, it was announced recently by the National Electrical Manufacturers Association.

For the past year a committee of the Industrial and Commercial Lighting Equipment Section of N.E.M.A. has been engaged in preparing the program. Its recommendations were unanimously accepted by the members attending the section's recent semiannual meeting and funds to cover the operation until January 1, 1955 were voted.

A National Lighting Bureau is to be set up at N.E.M.A. headquarters in New York City to work with local lighting bureaus. In the initial stages the National Lighting Bureau will set up a small number of pilot activities to test out every phase of the program, after which it will be promoted on as wide a scale as possible.

Essentially the relighting program is designed for all industry participation. An executive committee from the N.E.M.A. section will invite the assistance of advisors from the several national electrical associations and others. Local bureaus will also be organized on an all industry basis.

If possible, the first pilot operation will begin this fall and the entire program is expected to be in operation by next spring. Already requests have been received for consideration as pilot locations.

Inasmuch as the N.E.M.A. section's previous Test City market research had disclosed that lighting in more than 85 per cent of the commercial and industrial interiors was substandard, the present program was designed to promote relighting that is at least up to the minimum accepted standards and practices. This is to be accomplished through certification of installation. The minimum standards and practices are those published by the Illuminating Engineering Society.

Certifying authorities will be set up by the local bureaus to examine plans prior to installation. Plans that meet the minimum standards and practices will be stamped for certification and when the installation follows the plans, the installing contractor may so certify and warranty the job. Certificates will be countersigned by the certification authority.

Simplified methods for determining compliance have been developed and every effort has been made to reduce paper work to the minimum. Installations only and not equipment will be certified. Minimum standards and practices will cover both quantity and quality of illumination.

A survey of utilities and wholesalers disclosed an almost unanimous desire for a sales training program designed to fit the problems of the relighting market. The National Lighting Bureau is authorized to develop such a sales training manual after field investigation of the problem attending the sale of relighting.

At the same time written courses in lighting techniques will be prepared. The first course will cover the elementary phase of lighting and the advanced course will take up design through a series of actual cases.

All costs for operating the National Lighting Bureau and national promotion are being carried by the Industrial and Commercial Lighting Equipment Section of N.E.M.A. This is the Section's first market development program and, according to its chairman, W. P. Lowell, Jr., it has received enthusiastic encouragement from every other branch of the electrical industry.

Holophane Opens New Engineering Center at Newark, Ohio

Holophane Co., Inc., inaugurated a new Engineering Center in Newark, Ohio, with an open house and inspection of the Center on June 10. Additional research in the field of luminaire performance and many other phases of illumination are planned for the new photometric, visual evaluation and general testing laboratories.

Of particular interest to visitors at the opening was a new photometer with a clear test distance of 25 feet, for use in testing all luminaires, both vertically and horizontally, under actual application conditions. A photoelectric cell traveling on an arc of 25 feet radius registers the light output. By turning the units in the photometer upside down, upward light components can be measured. For readings at various lateral orientations, the units can be turned in the photometer by rotating them in a horizontal plane. The movement of the photoelectric cell and the rotation of the units in the photometer head are carried out by electric motors connected to an electronically operated push button system, thereby making it possible for the photometer to be operated by remote control.

Separate general testing laboratories facilitate handling of various tests such as heat, endurance, vibration and weathering. Foremost in consideration is the testing of luminaires under conditions of actual operation.

The visual evaluation laboratory permits the mounting of luminaires both in flush and surface attached installations. One wall of this room, equipped with a grid of reference lines and angles, simulates in miniature an actual street to check performance of new street lighting refractors by visual appraisal.

The new laboratories, to be used in design work, will be under the supervision of Kurt Franck, Chief Engineer in charge of product development.

BANQUET and dance at the Midwestern Regional Conference were held in the ballroom of the Hotel Radisson.

Midwest Region Members Meet in Minneapolis

Attendance at the two-day (April 30 and May 1) Midwestern Regional Conference topped 200. While the number registered doesn't always cinch a meeting's success (except to the conference finance chairman), all other details of the Minneapolis conference, as well, were outstanding. In view of the happy reaction of those attending, the following touches could well be recommended for general practice.

1. A full set of Conference papers, mimeographed in advance, to each delegate.

2. Organized discussion at each technical session.

3. A "convention-scale" ladies' program headed by an enthusiastic committee.

4. Inspirational luncheon addresses by leading executives, from both business and the Society.

5. Papers well in line with the intent of Regional meetings; *i.e.* not as highly technical as a national conference program, nor as general in nature as a Section meeting, and full of meat.

6. Scrupulous attention to small details —like raffling off the table flowers to ladies, after the dance. A really funny gag speaker at the banquet. Refreshments right outside the ballroom. A conference headquarters suite, for committee meetings, contest judges' deliberations and general usefulness. A map and list of Minneapolis lighting installations in each delegate's envelope. A chartered bus tour, with guides to discuss lighting details of installations throughout both Twin Cities. An attendance prize for Section having largest number present.

7. To name but a few.

Who Was There

A bulletin system started back in February, with intermittent reminders and stimulation, apparently paid off in conference attendance. Although the Midwest Region covers the largest territory of any in the U. S. (the wide expanse of Canada is the only larger I.E.S. Region) registration was better than 200, with three Chapters missing, however. Publicity apparently spread far, since five couples from the Canadian Region (Winnipeg Chapter) came over the border to attend. Canadian delegates were L. MacKenzie (Winnipeg's Chairman), J. Sector, K. Wood, J. McFazean, and A. C. Bernard. Their wives were five of the 35 out-of-town ladies at the conference. St. Louis Section and Chicago Section tied for the attendance prize, bottles of Creme de Menthe, accepted by Lee Wallace and Bill Weibel, Chairman of the winnings groups. Seven Local Representatives from outlying regional territory were present: J. C. Gehan, Waterloo, Iowa; E. F. Evenson, Ashland, Wis.; W. B. Hall, St. Cloud, Minn.; G. W. Frederick, Sioux Falls, S. D.; Gordon Bonvallet, Decatur, Ill.; C. L. Seaquist, La Crosse, Wis.; and L. A. Gauthier, Mankato, Minn. In the circumstances of the excellent papers sessions, these men took back a good report of Society work.

Attendance at Minneapolis

Twin City Section	96
St. Louis Section	14
Chicago Section	22
Milwaukee Section	10
Iowa Section	10
Cornhusker Chapter	5
Twin Ports Chapter	8
Non Regional	10
Ladies	55
Total attendance	230

M. M. I. L. J.

The Midwest Region's contest for My Most Interesting Lighting Job was also a highly organized affair. Each of the ten Sections and Chapters appointed local Chairmen to handle the contest, working with Eric H. Church of Chicago who served as Regional Chairman. Five Sections participated, three sending winners to the Regional contest. Six impartial judges at the regional contest chose:

1st Prize — Harry Koether, Milwaukee Section, a store lighting installation.

2nd Prize — Hank Poehling, St. Louis Section — an industrial lighting job.

3rd Prize — L. J. Reigert, Twin City Section, a school.

Unable to present their installations at the Region Contest were Douglas McIlvaine, first place winner for Indiana Chapter and Charles Young, Iowa Section.

Technical Program

In addition to the papers program listed below, two outstanding addresses were made at the Midwest Regional by President E. M. Strong, who spoke on the theme "I.E.S. — Inspiration, Education and Service." Prof. Strong illustrated his address with slides showing the Society's organization and service. He also addressed a luncheon meeting held during the Conference for 42 incoming and outgoing local officers and local representatives. The technical program featured a "School Lighting Symposium"

SERIOUS preparation of many of the contestants in the My Most Interesting Lighting Job Contest is evidenced by this scale model classroom, built to demonstrate a solution to a school lighting problem. Contestant L. J. Riegert, Twin City Section, is at right. At left are Gordon Moore and Richard Hammel.

AT THE dinner, guest of honor was I.E.S. President E. M. Strong, who is pictured here with Mrs. L. B. Paist; L. B. Paist, Regional V-P; Mrs. D. P. Greene, and D. P. Greene, Chairman of the Twin City Section, which was host Section to the Conference. Attendance at the banquet was over 260 members and guests.

for one of its sessions, and papers as follows:

Thursday Morning, April 30

Chairman, James H. Hull
Chairman, Iowa Section

"Introduction to the Conference" — Louis J. Riegert, General Chairman
Address of Welcome
Lawrence B. Paist, Midwestern Regional Vice President
President's Address
Prof. E. M. Strong, National President I.E.S.
"Trends in Industrial Lighting and the New ASA Standard" — Merle E. Keck, Westinghouse Electric Corporation
"Light and Color in Design" — Prof. John A. Russell, Director of the School of Architecture, University of Manitoba, Winnipeg

Thursday Noon, April 30

Chairman, Wm. A. Weibel
Chairman, Chicago Section

Luncheon — Address by Allen S. King, Executive Vice President, Northern States Power Co.

Thursday Afternoon, April 30

Chairman, L. M. Wallace
Chairman, St. Louis Section

"Brightness vs Illumination for Luminous Ceilings" — Robert D. Barnham, F. W. Wakefield Brass Company.
"Store Lighting — Creating a Selling Environment with Light" — C. M. Cutler, General Electric Company
"Progress Report." Also films on Light, Sound and Motion — Lawrence E. Johnson, Northern States Power Co.

Friday Morning, May 1

Chairman, Leland M. Wallace
Chairman, St. Louis Section

"Most Interesting Lighting Job Contest" — Eric H. Church, Moderator

Friday Morning, May 1

Chairman, Everett H. Schaefer
Chairman, Milwaukee Section

"School Lighting and Posture" — Willard Allphin, Sylvania Electric Products, Inc.
"Daylight and the School Room in Northern Climates" — Richard F. Hammel, Consulting Architect for St. Paul Public Schools, and Gordon Moore, Gausman & Moore, Consulting Engineers.
"How Better School Lighting Has Improved the Quality of Education" — Dr. Rufus A. Putnam, Superintendent of Schools, Minneapolis, Minn., and Gilbert Lee, Asst. Supt. of Buildings and Grounds, Minneapolis Public Schools.

Friday Noon, May 1

Local Activities Luncheon — L. B. Paist, Regional Vice President, Chairman
Tour of Lighting Installations.

Friday Evening, May 1

Banquet and Dance — Donald P. Greene, Presiding Chairman, Twin City Section. Carl T. Bremicker, Master of Ceremonies.

The Progress Report given at Minneapolis was presented by a local member of that committee, L. E. (Duke) Johnson. Mr. Johnson's show was exceptionally well done, with a stage full of new equipment displayed — including a demonstration of three D in color.

Highlight of the social program was the dinner dance May 1, honoring President Strong. Some 263 members and guests attended this banquet, and were very glad they did. Carl T. Bremicker as M.C. sparked the pace, which never lagged. Entertainment through dinner, a really good gag speaker, plus a fine magician, was followed by dancing till the small hours.

Ladies' Program

Some 55 ladies attended at Minneapolis. Thirty five of these were from out of town. As with the other details of this conference, the success of the ladies' program was the result of careful planning, underway for weeks in advance. With Leone Paist (Mrs. L. B.) as Chairman, each committee member was assigned a "project" — and directed completely her item of the program. The ladies who enjoyed this program, and the Conference Committee in general, are indebted to Mrs. Paist, Mrs. L. J. Riegert, Mrs. A. A. Aronson, Mrs. L. E. Johnson, and Mrs. Don Greene. These hardworking members conducted such items as the Brunch at the Interlochen Club, scenic tours of the Minneapolis area, Sibley House, a luncheon and style show for which the Moderator was Mrs. Grace Kenney, head stylist at Dayton's and the wife of an I.E.S. member. On Thursday, Mrs. A. L. Weidt entertained the group for tea at her home.

Credit Due

Great credit, indeed, is due to the planners of the Minneapolis Conference, who were:

Vice Chairmen

R. H. Rahe, Chairman, Central Illinois Chapter
W. A. Weibel, Chairman, Chicago Section
E. E. Schwalm, Chairman, Cornhusker Chapter
W. E. Stiers, Chairman, Heart of America Section
S. E. Jenkins, Chairman, Indiana Chapter
J. H. Hull, Chairman, Iowa Section
E. H. Schaefer, Chairman, Milwaukee Section
L. M. Wallace, Jr., Chairman, St. Louis Section
D. P. Greene, Chairman, Twin City Section
G. P. Spurlock, Chairman, Twin Ports Chapter

Conference Executive Committee
Twin City Section

L. J. Riegert ..... General Chairman
L. E. Johnson ..... Secretary
J. O. Kvalsten ..... Treasurer
C. H. Branham ..... Papers
A. H. Kessler ..... Attendance and Publicity
L. G. Hamilton ..... House
R. D. Coons ..... Reception and Transportation
R. E. Steele ..... Hotel and Registration
A. A. Aronson ..... Entertainment

Maryland Section Host to East Central Regional Conference

Baltimore, Maryland, noted for its Southern graciousness, injected a considerable share of this characteristic into the regional conference held there May 14 and 15. Balmy May weather and a fine program were added dividends.

The conference was under the general direction of Paul H. Hildebrand, Regional V-P and was conducted by Edmund S. Barrington as Chairman, and Mason C. Albrittain as Honorary Chairman. In addition to the 106 delegates registered, the conference was also host to the Council Executive Committee, headed by I.E.S. President E. M. Strong, which held its May meeting there just prior to the conference opening.

Technical Program

An exceptionally interesting group of papers were presented during the two days of technical sessions, including outstanding addresses by C. P. Crane, President of Consolidated Gas Electric Light and Power Company of Baltimore, I.E.S. President Strong, and Dr. Israel Dvorine, ophthalmologist. The program in detail was:

Thursday, May 14, 1953

Morning Session

Chairman, C. J. Estabrook

Capital Section

Conference called to order by Honorary Chairman, Mr. M. C. Albrittain, Consolidated Gas Electric Light & Power Co. of Baltimore.

Welcome Address by C. P. Crane, President, Consolidated Gas Electric Light & Power Co. of Baltimore.

What Has Happened to Lamps and Ballasts? by R. W. Townsend, Westinghouse Electric Corp., Bloomfield, N. J.

Luncheon — Founder's Room, Lord Baltimore Hotel. I.E.S. President's Address by Prof. E. M. Strong.

Afternoon Session

Chairman, G. H. Maize

Pittsburgh Section

Forum on Visibility.

Optical Aids for Better Seeing, by Dr. Israel Dvorine, Baltimore.

Visibility of Task, by James M. Ketch, General Electric Co., Cleveland, Ohio.

Studies in Physiological Cost of Seeing, by Willard Allphin, Sylvania Electric Products Inc., Salem, Mass.

Discussion by Paul H. Hildebrand, Regional Vice-President.

Thursday Evening

Chairman, E. S. Barrington

Maryland Section

Banquet and Entertainment — Caswell Room, Lord Baltimore Hotel.

Principal Address — Mr. John R. T. Hedeman, Past President, Kiwanis Club.

Friday, May 15, 1953

Morning Session

Chairman, T. W. Lauer

Philadelphia Section

"My Most Interesting Lighting Job" presentations — Five speakers (one from each Section).

Afternoon Session

Chairman, E. W. Halteman

Eastern Pennsylvania Section

Relationship of Brightness and Illumination Levels for Luminous Ceilings, by Robert D. Burnham, F. W. Wakefield Brass Co., Vermilion, Ohio.

Acoustics and Lighting, Eric H. Church, Benjamin Electric Mfg Co., Des Plaines, Ill.

Presentation of Awards for "My Most Interesting Lighting Job" contest — by Paul H. Hildebrand, Regional Vice-President.

M. M. I. L. J.

My Most Interesting Lighting Job contest started in the East Central Region. By long experience they well know how to conduct this activity for its best effectiveness. Their contest this year had five outstanding entries, presented under the session chairman, T. W. Lauer. Judges decisions went to:

First Prize: L. E. Spears, Pittsburgh Section, for a store lighting installation.

Second: Jerome B. Trout, Maryland Section — Hecht's store.

Third: W. N. Harrison and W. G. Taylor, Philadelphia Section.

Runners up — Russell H. Stewart, Eastern Pennsylvania Section and Herbert C. Smith, Capital Section (the latter by default).

Mr. Spears, Pittsburgh's representative, will represent the Region at the contest finals being conducted by the Lighting Service Forum at the National Technical Conference in New York next September.

LADIES' Program included a tour of early American homes, a sight-seeing boat trip and two special luncheons.

Entertainment

The East Central Region staged a really nice banquet and dance. A look at the program shows "principal speaker John R. T. Hedeman," which sounds routine but was far from that. Mr. Hedeman a skilful professional whose "address" was an extremely funny and high-

SOME of the principal speakers on the technical program of the East Central Regional Conference were James M. Ketch, of General Electric; Willard Allphin, Sylvania; Dr. Israel Dvorine, Baltimore Ophthalmologist; and Paul Hildebrand, Pennsylvania Power and Light Co. and Vice President of the East Central Region.

HIGHLIGHT of the luncheon at the East Central Regional Conference was the President's Address, presented by I.E.S. President E. M. Strong, shown here with others at the head table. This luncheon was held in the Founder's Room at the Lord Baltimore Hotel on the first day of the conference. President and Mrs. Strong were the guests of honor at the banquet, which was held that evening, when they were presented with gifts from the Region.

CONTEST for My Most Interesting Lighting Job, which initiated in the East Central Region, had enthusiastic participation. Here are shown, runner-up Russell H. Stewart, Eastern Pennsylvania Section; W. A. Taylor and W. N. Harrison, Philadelphia Section, whose joint entry won third place; and L. E. Spears, Pittsburgh Section, whose first place winner will represent the Region at the National Conference this September.

ly entertaining act. In spite of the laughter it took about 15 minutes to catch on that all this was intentional.

President and Mrs. Strong, who were guests of honor at dinner, were presented with umbrellas, products of a famous Baltimore industry, as a gift from the Region.

An enjoyable ladies' program was also part of the entertainment. Visiting ladies participated in a get-together at Hampton House; a tour of early American homes in the Baltimore region; sightseeing boat trip of the Port of Baltimore; and a special luncheon at Hochschild Kohn.

For delegates staying over Saturday, arrangements were made to attend the Pimlico races which were run the day after the Conference.

Credit Due

As with most well-run conferences, credit is due a great many hard-working local members. Special credit, however, should go to the following committee chairman, and congratulations as well:

Paul H. Hildebrand....Regional Vice-President
Mason C. Albrittain.....Honorary Chairman
Edmund S. Barrington.....General Chairman
E. W. Halteman — G. W. Maize
T. W. Lauer — C. G. Estabrook
H. M. White, Co-Chairman
Charles Newbraugh, Co-Chairman
G. Fred Walter, Secretary

Publicity.....C. J. Berry
Program.....Lee Morgan
Finance.....Robert L. McCalley
Papers.....John Hoffmann, III
Hotel.....C. Harmon Bronner
Registration.....C. E. Sparrow, Jr.
Ladies' Program.....John M. Asher
Entertainment.....Robert H. Stott
Arrangements.....John Bibby
Pimlico.....P. Mason Wood

New York Section Conducts Architectural Contest

At the final meeting for the New York Section May 28, awards were made to winners of the contest conducted by the Section for architectural students of Columbia University and Pratt Institute. Checks and prizes were presented to

First Prize for Pratt Institute — Joseph D'Amelio, $25.00.

First Prize for Columbia — Leon Haft, $25.00.

Second for Pratt — Richard Moger, $10.

Second for Columbia — Irving Wiener.

Each winner also received an I.E.S. Lighting Handbook and a Student Membership in I.E.S. Prizes were awarded by Marshall Waterman, Section Chairman, following presentations of the winning designs by judges Richard Kelly and Alex Sitkin. Other judges in the contest were R. P. D. Clarkson, and Alfred E. Poor, architects.

Design problem assigned to the students was the redesign and relighting of a space which was being converted from a supermarket to a suburban library.

New York Section member L. R. Anderson (General Electric) lectured at each school, prior to the contest, on illumination. An interesting by-product of the project, was requests, from both schools, for more such lectures to architectural students.

The award presentation, held at a dinner meeting at the Old Brew House, New York, followed an inspection tour by 90 New York Section members of the United Nations Building.

Southern Regional Conference

A full report on the Southern Regional Conference, I.E.S., will be carried in the August issue of ILLUMINATING ENGINEERING.

Industrial Lighting Standard Becomes Government Document

The new American Standard Practice for Industrial Lighting, published by the I.E.S., has been adopted by the United States Department of Labor, Bureau of Labor Standards for use in their training programs. In a letter to Walter Sturrock, Past-President of I.E.S., who acted as liaison with the Labor Department in making arrangements, William L. Connolly, Director of the Bureau of Labor Standards, says in part:

> "You may be interested in knowing that we use this standard as the basis for one of our training courses in safety, which reaches not only representatives from State labor departments but also a considerable number from the ranks of both management and labor. Each student is provided with a copy of these recommended practices, and through this medium we reach several hundred key people each year who might otherwise be unfamiliar with your excellent publication."

Under the special arrangements made between the Society and the Labor Department, 10,000 copies of this standard were supplied for their use.

Syracuse Host to Successful Great Lakes Regional Conference

Very close inter-Section cooperation was a conspicuous ingredient in the success of the Great Lakes Regional Conference, May 25 and 26. Site was the Syracuse Hotel, Syracuse, N. Y., with the Central New York Section chief host. Registered attendance was 270.

Actually the meeting started Sunday evening at eight, with a Regional Board Meeting of considerable importance to local operation. Discussion, from the 25 incoming and retiring Section and Chapter officers and local representatives present continued with enthusiasm for some 3½ hours. Among other matters discussed was the location of next year's regional conference. Successful candidate for that meeting was the Michigan Section, who will be host in 1954 at the Sheraton Cadillac Hotel, Detroit. With the National Conference scheduled for Cleveland in 1955, there will be no regional that year, but Toledo is bidding hard for 1956. The importance of I.E.S. Regional Conferences seems to be pointed up in the keen competition evidenced everywhere for the conference location, hard work notwithstanding.

Hard work made the Syracuse meeting seem effortless. A list of some of the people responsible for this well-organized affair is given at the end of this report; some of the successful techniques are as follows:

Good Ideas

1. Booklet-type programs with 16 blank pages for notes.
2. A pocket size folder containing everything pertaining to the meeting—tickets, program, local map etc.
3. A fully-organized ladies' program, printed separately in attractive format.
4. Session Chairman in charge of each session, controlling timing and discussion, which was lined up in advance.
5. Lighting and decorations were a major project, and were designed and executed by an experienced committee man (W. A. Lampenin).
6. Intra Region unity was emphasized, not only in the display of Section and Chapter names in decorations and elsewhere, but in active participation of local representatives as well as Section and Chapter Chairmen.
7. Smooth registration by attractive feminine personnel (Marylin Forster of Niagara Mohawk; Miss A. C. Rose of Crouse-Hinds).

M. M. I. L. J.

A major, and popular, feature of nearly all regional meetings this year was the contest for "My Most Interesting Lighting Job." In the Great Lakes Region it was apparently a major project locally for all concerned, prior to the regional, since very particular preparation was evident for all entries. Seven entries were scheduled, but unfortunately Western Michigan's representative, Ralph Smith, Graybar Electric Company, Flint, Michigan, was unable to attend. The big new job which prevented his attendance may have resulted from his successful local participation? The six Sections and Chapters represented were:

First Prize: Nick Stuffer, Cleveland Section, who skilfully described unique lighting solutions for an executive's office.

Second Prize: Raymond Metzger, Jr., Northwestern Ohio Chapter, who solved a problem for a football field.

Third Prize: Alfred Sangster, Michigan Section, a church lighting job of great merit.

Runners up were R. H. Goodman, Central New York Section with a lighted swimming pool; Earl Miller, Rochester Section, an airport administration building; and Ohio Valley Section, a fluorescent street lighting job.

Cleveland Section will represent the Region at the National Technical Conference contest, with Mr. Stuffer's entry.

Technical Program

Technical sessions at the Great Lakes Regional were carefully timed, discussion well organized. The program presented was:

Monday Morning — May 25
Chairman, D. W. Rowten
Cleveland Section

Welcome Address, General Chairman A. H. Clarke.

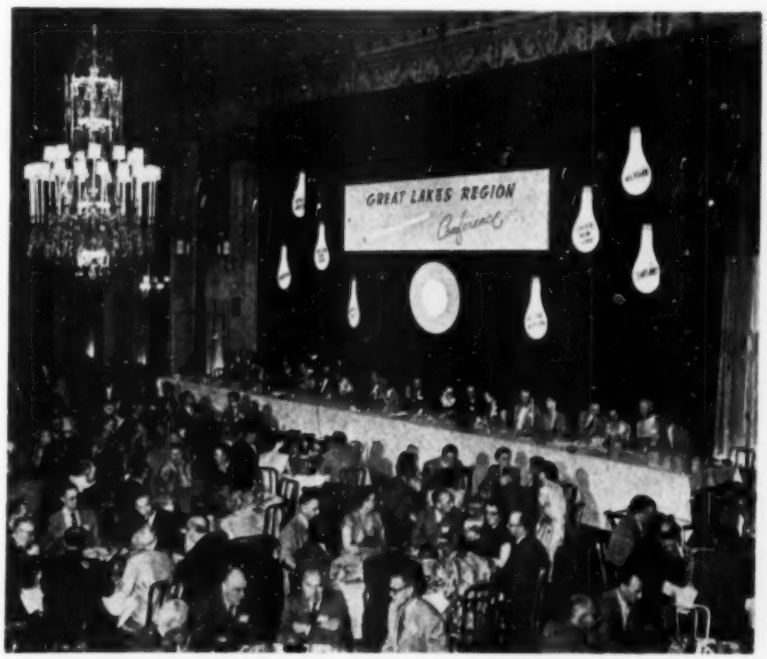
Greetings, Regional Vice-President L. C. Twichell.

Address, National President E. M. Strong.

"Practical Ballasting of Fluorescent Lamps," by R. D. Bradley, Day-Brite Lighting, Inc.

Great Lakes Regional Attendance

	I.E.S. Members
Central New York Section	46
Rochester Section	28
Michigan Section	23
Cleveland Section	21
Western New York Section	8
Northwestern Ohio Chapter	4
Ohio Valley Section	2
Western Michigan Chapter	1
Outside Region Members	24
Non-Members Registered	40
Ladies	73
Total	270



DECORATIONS on the backdrop behind the head table are huge lamps with the names of the Sections and Chapters comprising the Region. In the center is the emblem of the Central New York Section, host Section to the Conference.

ONE HIGHLIGHT of the technical program was a demonstration by Dr. W. W. Shaver of Corning Glass Works, "New Advances in Technical Glass."

"Ventilation — The Key to Self Maintenance," by Floyd Sell, The Detroit Edison Co.
Luncheon Session, Chairman, N. T. Kridel, Rochester Section.
"New Advances in Technical Glass — Demonstration," by Dr. W. W. Shaver, Corning Glass Works.

Monday Afternoon — May 25
Chairman, J. A. DeWinter
Western Michigan Chapter

"A Closer Look at Brightness Engineering," by Gene Rae, The Holophane Company, Inc.
"My Most Interesting Lighting Installation Contest," Moderator — D. E. Vincent.

Monday Evening — May 25
General Chairman, A. H. Clarke

President's Reception and Cocktail Hour.
Dinner.
Entertainment — American Legion Chorus — A Half Hour Program by Syracuse Post 41, National Champions.

Tuesday Morning — May 26
Chairman, R. J. Schulte
Ohio Valley Section
Discussion Leader, W. A. Biser
Western New York Section

"Brightness vs. Illumination for Luminous Ceilings," by R. D. Burnham, The F. W. Wakefield Brass Company.
"Lighting the Low Ceiling Classroom," by Carl Allen, General Electric Co.
"Store Lighting — Turn Senses into Dollars," by R. C. Allison, T. Eaton Company.

Luncheon Session

Presentation of Regional Awards for the "My Most Interesting Lighting Installation Contest" — Vice President L. C. Twichell.

Tuesday Afternoon — May 26
Chairman, L. D. Lyon, Michigan Section
Discussion Leader, H. C. Doner, N. W. Ohio Chapter

"Street Lighting as Affected by the New A.S.A. Standards" by E. B. Karns given by Chas. Rex, Westinghouse Electric and Mfg. Co.
"How to Photograph Lighting Installations," by T. Knowles, General Electric Co.
"Lighting Progress Report," by T. C. Sargent, Sylvania Electric Products Inc.

ENTERTAINMENT

The President's Reception and dance Monday evening was the main respite from business for conference delegates, but the 73 ladies attending had an exceptionally fine program of entertainment. Highlight of it was, of course, the dance. President and Mrs. Strong were guests of honor and received during the brief banquet speeches, a beautiful Steuben vase and candlestick presented on behalf of the Great Lakes Region by V-P L. C. Twichell. Mr. Twichell himself was presented with a silver pitcher as a token of appreciation from the Region.

As with other features of the meeting, the ladies' program was very well planned indeed. In addition to the banquet and dance, they participated in a planned tour of the Onandaga Pottery Plant; Corinthian Club luncheon and card party; style show and luncheon at the Persian Terrace (Syracuse Hotel) and a number of informal items.

CREDIT DUE

Central New York Section as a whole deserves credit for this first Syracuse regional meeting. In particular, the following members directed details:

Conference Committee

Honorary Chairman	L. C. Twichell
Chairman	A. H. Clarke
Program	J. W. Bigley
Finance	C. L. Peckham
Entertainment	W. H. Lawrence
Publicity and Attendance	T. S. Harmon
Registration and Reception	R. H. Goodman
Transportation	J. S. Haney
Decorations and Lighting	W. A. Lampinen
Hotel	E. D. Britt
General	C. L. Cottrell

Ladies' Committee

Registration Chairman	Mrs. T. S. Harmon
Transportation Chairman	Mrs. J. S. Haney
Pottery Tour Chairman	Mrs. J. J. Hughes
Luncheon-Bridge Chairman	Mrs. A. H. Clarke
Luncheon-Style Show Co-Chairmen	Mrs. J. W. Bigley Mrs. W. J. Byrne

REGIONAL V-P Les Twichell holds aloft the silver pitcher presented to him by the Region. President Strong was the recipient of some lovely Steuben glassware.

ENTERTAINMENT at the banquet included a half-hour program by the American Legion Chorus of Syracuse Post 41, national champions.

Extension Meetings Held By New England Section

"A review of everything important to the art and science of illumination in all fields of lighting during the past year" is the summing up of an extension meeting of the New England Section in Worcester, Mass., May 7. The meeting, held at the Worcester Polytechnic Institute, featured Ted Sargent and his Progress Report. Attendance at this meeting was 125, and at a previous one in Providence, Rhode Island reached 200. These meetings were arranged by R. G. Slauer, Extension Meeting Chairman of the New England Section.

San Jose Chapter's Gavel Made of Historic Wood

The gavel presented to the San Jose Chapter by the "next youngest" I.E.S. chapter, Eastern New York, brings a bit of Revolutionary War history out to the far west. The gavel is made from a piece of a rafter taken from the Headquarters House in Newburgh, New York, occupied by General George Washington from April 1782 to August 1783. Donated by authority of the Board of Trustees of Washington's Headquarters, the wood used in fashioning the gavel was from a rafter removed from the roof during repairs made in 1952.

Annual Spring Conference Held by Milwaukee Section

The usual successful Annual Spring Conference (fifth, this year) of the Milwaukee Section, I.E.S. was held May 21 at the Milwaukee Elks Club, with I. L. Illing as Chairman of the Conference Committee. The program, which got to a start at 8:30 a.m., was as follows:

Registration.
Light Sources that Have Come of Age — Ben Avery, General Electric Co., Lamp Division, Milwaukee, Wis.
The Ballast Story:
New Lead Lag Developments — James C. Weeks, Westinghouse Electric Corp., Chicago, Ill.
New Series and Rapid Start Developments —A. E. Rowe, General Electric Co., Special Transformer and Ballast Division, Fort Wayne, Indiana.
Milwaukee's Big League Lighting Installations — Charles Laupp, Wisconsin Electric Power Co., Milwaukee.
Luncheon.
Qualified Contracting Insures Satisfaction — Rudy Knoerr, Knoerr & Fischer, Inc., Milwaukee, Wis.
Lighting in Business Has Gone Big League — D. P. Caverly, Sylvania Electric Products Inc., New York, N. Y.
Lights—Camera—Action — Professor Theodore Fuchs, Northwestern University, Evanston, Ill.

Registration at the all day conference was 152.

I.E.S. Research Fund and University of Michigan Co-Sponsor Conference on Light and Vision

A Conference on Light and Vision, sponsored by the University of Michigan and the I.E.S. Research Fund, was held June 8 and 9 in Ann Arbor, Michigan. Attendants included 62 representatives of industry, color specialists, ophthalmologists, professors, and medical doctors.

The Conference acquainted participants with the light and vision research program of the Vision Research Laboratory of the University of Michigan. This laboratory, under the direction of Dr. H. Richard Blackwell, is affiliated within the University with the Departments of Psychology and Ophthalmology, the Institute of Industrial Health, and the Engineering Research Institute.

The second phase of the Conference presented a symposium of light and vision research which included discussion of the various research projects now being carried on under the auspices of the I.E.S. Research Fund.

Each speaker presented his subject in simplified form, readily applicable to everyday work. The benefits to workers in industry were brought out including improved performance due to determination of quantity and quality of illumination for particular tasks, decreased effort, greater use of skill (compensation for age through illumination), and means for determination of acceptable colors for the working environment. Glare is found to be uncomfortable because of causing the pupils of the eyes to close down.

The program included lectures on the objectives and results of the light and vision research program of the University of Michigan by Dr. Blackwell, the visual factors in the perception of light and color by Dr. Harry Helson, Professor of Psychology at the University of Texas; vision research at the Institute for Applied Experimental Psychology, by Dr. Leonard C. Mead, Research Coordinator at Tufts College, re-evaluation of the scattering theory of disability glare, and the relation of fluctuations in pupil diameter to visual comfort by Dr. Glenn A. Fry, Director of the School of Optometry at Ohio State University; and an illustrated talk on color by Ralph M. Evans, Secretary of the Inter-Society Color Council.

The group was also addressed at luncheons and dinners by Dr. Marvin L. Niehuss, Vice-President and Dean of Faculties of the University of Michigan; Dr. A. C. Furstenberg, Dean of the Medical School at the University of Michigan; Dr. O. T. Mallery, Jr., Director of the Institute of Industrial Health at the University of Michigan; and Professor E. M. Strong, President of the Illuminating Engineering Society.

Guests were conducted on a tour to points of interest on the University of Michigan campus including the Daylighting Laboratory, directed by Dr. R. A. Boyd, and the model room research being carried on by Professor Hempstead S. Bull in the Illumination Laboratory.

In addition to the symposium, the Technical Advisory Committee on Light and Vision and the Research Executive Committee of the I.E.S. Research Fund met to review progress of all research projects and to consider new proposals.

THE 152 ATTENDING the Milwaukee Section Annual Spring Conference listen to guest speaker, D. P. Caverly, who spoke on modern methods in planning lighting coordinated with construction design.

FIRST PRIZE certificate in the Lighting Design Competition of the New York Residence Lighting Forum is presented to Jack Scaparro by Forum Chairman Edith Buchholtz as distinguished guests look on.

THIRTEEN students from the New York City vocational schools won certificates and prizes in the competition. Over 1000 students from the 19 schools participating entered the competition, which is held annually by the Forum.

Student Competition Prizes Awarded By N. Y. Residence Lighting Forum

The New York Residence Lighting Forum of the I.E.S. concluded its successful year's program June 10 with a tea meeting at which the awards were made in the annual lighting design competition. The competition, open to all New York City vocational high school students, was to prepare complete plans for the artificial lighting of a typical one-floor apartment in a converted brownstone house, occupied by a representative family with stated hobbies and occupations. Winners were chosen on the basis of the success with which they solved the lighting problems involved, with primary emphasis on practicality, comfort and aesthetic merit, as well as the technical rendering of the presentation.

Awards were presented to 13 boys from the 19 vocational high schools participating, by Miss Edith Buchholtz, Forum Chairman, and Thomas Smith Kelly, one of the judges. Winners were:

First and Second Prizes — Jack Scaparro, Jr., and Claude Steblai, Machine and Metal Trades Technical and Vocational High School.

Third Prizes — John Palmer and Robert Pearson, Williamsburgh Vocational High School; Alfred C. Costanzo and R. H. Bauer, Samuel Gompers Vocational and Technical High School; William Bianchi and Carl Jurgens, Jr., Machine and Metal Trades Technical and Vocational High School; Eugene Profeta, East New York Vocational High School.

Honorable Mention — Vito Anthony Grillo and Richard Garrabrant, Machine and Metal Trades Technical and Vocational High School; Peter Sclafani, East New York Vocational High School, and Joseph Uliano, Williamsburgh Vocational High School.

Held at the Cooper Union Museum, the meeting was honored by the presence of Dr. Edwin S. Burdell, President of Cooper Union and Dr. E. Maurice Bloch, director of the museum, as well as such important local school administrators as Dr. C. Frederick Pertsch, Associate Superintendent of the New York City Schools, and Mrs. Dorothy Thornton, Supervisor of Industrial Design for the vocational high schools. Winners were congratulated by George Taylor, V-P of the I.E.S. Northeastern Region. Miss Lillian Eddy, home lighting specialist, gave a critique of the winning entries, which were on display. Co-Chairmen of the competition committee were Miss Caroline Horn and Mr. Thomas Smith Kelly. Miss Eddy, Mr. Kelly, and Mr. Berlon Cooper, of *Electrical Construction and Maintenance*, served as judges.

ABOUT PEOPLE

R. M. Johannesen, president of Johannesen Electric Co., Greensboro, N. C., has been elected president of the National Association of Electrical Distributors, succeeding **George F. Hessler,** vice-president of Graybar Electric Co., New York City. Mr. Johannesen has been an I.E.S. member since 1946 and active in the affairs of the Carolinas Section. Other N.A.E.D. officers elected at their 45th Annual Convention are: **L. E. Barrett,** president of Barrett Electric Supply Co., as vice-president and chairman of the apparatus and supply division; **Herbert Schiele,** Artophone Corp., as vice-president and chairman of the appliance division; **T. B. Schmid,** Crescent Electric Supply Co., as member-at-large from the appliance division to the Board of Governors; and **P. O. West,** Doubleday-Hill Electric Co., as member-at-large from the apparatus and supply division to the Board of Governors.

Walter H. Sammis, president of Ohio Edison Co., has been elected president of the Edison Electric Institute.

On the recommendation of the Regional Nominating Committee, the I.E.S. Council took action at its June 10 meeting to appoint **Clarence Pederson,** of the Chicago Section, to fill the unexpired term of **L. B. Paist** as Regional Vice-President of the Midwestern Region.

The Engineering Institute of Canada has announced the election of the following officers, inducted into office, May 22. President: **R. L. Dobbin,** Peterborough, Ont.; Vice-Presidents: **I. M. Fraser,** Saskatoon, Sask.; **G. R. Henderson,** Sarnia, Ont.; **I. R. Tait,** Montreal, Que. In addition, 31 Councillors from the Institute's 29 branches were installed in office.

John D. O'Brien, director of sales and advertising of Jefferson Electric Co. since 1950, was elected vice-president in charge of sales by the company's board of directors, June 1.

David Crenshaw, formerly chief engineer of Columbia Electric and Manufacturing Co., has joined the staff of Supreme Lighting, Los Angeles, Calif., as design director. His duties will include advertising and public relations as well as luminaire design and engineering.

Roger Delander, Assistant District Manager, Southern Pacific Division of Sylvania Electric Products, Inc., has been promoted to Division Manager of the company's Pacific Northwest Division in Seattle. **Charles Connely,** formerly with Graham Reynolds Electric Co., has accepted a position with Sylvania in the Los Angeles Sales office.

Philadelphia Electrical and Mfg. Co. has announced two recent promotions in their company: **Leon Brown** has been named Chief Project Engineer and **Harry L. Weid** has been appointed Pac-

tory Manager. Mr. Weid succeeds **L. B. Hornberger,** who has been promoted to the Sales Department and placed in charge of the street lighting division.

Jefferson Electric Co., Bellwood, Ill., announces an expansion of its sales division and the appointment of **Frederick A. Delaney,** former head of advertising and merchandising, as sales service manager. Succeeding Mr. Delaney as advertising manager is **Joseph J. Archibald,** who had been assistant merchandising manager. Merchandising and sales promotion will be administered by **John E. Lee.**

H. L. Spear will represent the Illuminating Division of the Miller Company, Meriden, Conn., in the Oklahoma City, Tulsa and Dallas territory, with his headquarters in Oklahoma City.

OBITUARIES

Henry B. Dates

Henry B. Dates, Member Emeritus and Past President of the Illuminating Engineering Society, died May 17 at his home in Grosse Pointe, Michigan, at the age of 84. Professor Dates, who had been with the Case School of Applied Science (now Case Institute of Technology) from 1905 to his retirement in 1939, had a long and notable record as an educator in the electrical engineering field. His field of specialization was illuminating engineering and he had an outstanding record of service to the Society since its early days.

First joining the Society in 1907, Professor Dates served as Director, as Vice-President and in 1937-1938 as President, as well as member or chairman of many committees.

Of his numerous contributions to the advancement of illuminating engineering, the development of the I.E.S. "Student Lamp," by the Committee on Industrial and School Lighting under his chairmanship, is perhaps the most outstanding, as well as the I.E.S. certification of approved lamps. Also under his chairmanship, this Committee initiated researches in industrial lighting, resulting in recommended lighting practices for certain important industries.

In addition to his I.E.S. activities, Professor Dates was a Fellow of the American Institute of Electrical Engineers, member of the Illuminating Engineering Society of Great Britain, the Society for the Promotion of Engineering Education and of the United States National Committee of the International Commission on Illumination, and several technical associations of Cleveland.

Philip Peeples, member of the Society since 1931, died recently at the age of 52. An active force for the advancement of illumination in the Atlanta, Georgia area, Mr. Peeples had been a Local Representative of the Society and the first president of the Atlanta Lighting Club, before the formation of the Georgia Section, I.E.S., for which he did much of the preliminary planning. Mr. Peeples was Manager of the Commercial, Industrial and Street Lighting Sales Division of the Georgia Power Company.

M. C. Wilt, president of Curtis Lighting, Inc., Chicago, died suddenly June 11, at the age of 52. Well known as an executive in the lighting industry, Mr. Wilt had been a member of the Society since 1929. Prior to his appointment as president of Curtis Lighting, he had been Resident Engineer for the company and later Vice-President and General Manager of Curtis Lighting of Canada, Ltd., and then Executive Vice-President of the United States company. Mr. Wilt began his career in the lighting industry with the General Electric Company in Cleveland.

Election of New I.E.S. Officers

At a meeting of the I.E.S. Council held June 10, 1953, the report of the Committee of Tellers was presented, giving the results of the recent election of officers for the coming year, beginning October 1, 1953. The following have been elected to the offices indicated:

General Officers

President—A. H. Manwaring, Philadelphia Electrical & Mfg. Co., 1228 N. 31st St., Philadelphia 21, Pa.

Vice-President—Robert F. Hartenstein, Ohio Edison Company, Akron 8, Ohio.

General Secretary—Marshall N. Waterman, Westinghouse Electric Corp., Bloomfield, N. J.

Directors (Until 1956)—C. C. Shotwell, Philadelphia Electric Company, 1000 Chestnut St., Philadelphia, Pa., and W. A. Stannard, Consumers Power Co., 212 W. Michigan Ave., Jackson, Mich.

Regional Vice-Presidents—Canadian Region, M. B. Hastings, 1870 Davenport Rd., Toronto, Ont.; *East Central Region*, Clarence J. Berry, Consolidated Gas Electric Light & Power Co., Baltimore, Md.; *Inter-Mountain Region*, G. B. Buck II, General Electric Co., 1863 Wazee St., Denver 2, Colo.; *Southern Region*, Glenn E. Park, General Electric Co., 516 Johnstown Bldg., Charlotte, N. C.; *Southwestern Region*, Martin J. Myers, Jr., Public Service of Oklahoma, P.O. Box 201, Tulsa, Okla.

British Columbia Section

Chairman—R. W. Racine, British Columbia Electric Railway Co. Ltd., 570 Dunsmuir St., Vancouver, B. C. *Secretary-Treasurer*—L. S. Smith, Amalgamated Electric Corp., Ltd., 131 W. 2nd Ave., Vancouver, B. C. *Board of Managers*—H. J. Ashbee, J. H. Gilbreath, W. M. MacKenzie, A. E. Simpson.

Capital Section

Chairman—C. R. Engle, Jr., 7204 Harwick Rd., Washington 16, D. C. *Secretary-Treasurer*—Benjamin Goodman, 2039 Rosemont Ave., N. W., Washington, D. C. *Board of Managers*—C. G. Estabrook, R. E. Holmes, A. L. Rugo, H. C. Smith.

Carolinas Section

Chairman—George E. Wilkinson, P.O. Box 1339, Charlotte 1, N. C. *Secretary-Treasurer*—Benjamin C. Swain, 1945 Plaza Court, Charlotte, N. C. *Board of Managers*—A. L. Ducker, Jr., J. W. Marshall, J. H. Welch, Jr., J. M. Witbeck.

Central New York Section

Chairman—Daniel L. Killigrew, Corning Glass Works, Corning, N. Y. *Secretary-Treasurer*—William McNulty, Jr., Graybar Electric Co. Inc., 327 Northwest, Syracuse 1, N. Y. *Board of Managers*—D. R. Brown, W. A. Lampinen, W. H. Lawrence, L. I. Sweetland, Jr.

Chicago Section

Chairman—James R. Chambers, Benjamin Electric Mfg. Co., Des Plaines, Ill. *Secretary-Treasurer*—R. J. Diefenthaler, General Electric Co., 231 S. La Salle St., Chicago 4, Ill. *Board of Managers*—C. A. Baseduw, E. H. Church, C. W. Clarkson, W. A. Weibel.

Cleveland Section

Chairman—M. A. Mortenson, Jr., General Electric Co., Nela Park, Cleveland 12, Ohio. *Secretary*—F. L. Detwiler, The Cleveland Electric Illuminating Co., 75 Public Square, Cleveland 13, Ohio. *Board of Managers*—L. O. Banahan, W. S. Kolb, R. W. Morris, Allan Schwartz, G. P. Wakefield.

Connecticut Section

Chairman—Edward R. Cole, Hartford Electric Light Co., 266 Pearl St., Hartford, Conn. *Secretary*—L. A. Senofonte, The American Electric Supply Co., 175 Ann St., Hartford 3, Conn. *Board of Managers*—F. E. Brown, Jr., H. S. Kelly, W. E. A. Richards, A. Van Oss.

Eastern Pennsylvania Section

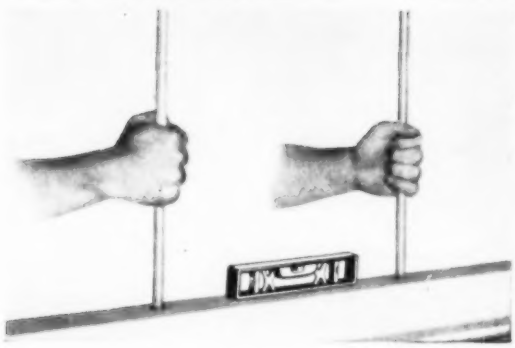
Chairman—Miles H. Keiffer, Electrical Engineering & Construction, Manheim, Pa. *Secretary-Treasurer*—F. M. Gochenaur, R. D. #3, Lititz, Pa. *Board of Managers*—P. E. Aumen, Leon Bell, E. W. Kelsey, H. T. Murphy.

Georgia Section

Chairman—H. R. Chappell, Whitehead Electric Co., 62 Techwood Drive, N. W., Atlanta, Ga. *Secretary-Treasurer*—W. C. Fink, Jr.,

(*Continued on page* 20A)

The Westinghouse CD has steel channel and end plates; plastic sides and bottom are polystyrene extrusions.



This Westinghouse quick spin-level feature saves time. Merely place level on unit and adjust by rotating the stems to level the fixture.

by: Hugh S. James
Duquesne Light Company
Pittsburgh, Pennsylvania

"Eye comfort is No. 1 problem when modernizing old schoolrooms"

In modernizing the lighting for this three-story grade school in Clairton, Pa., we considered eye comfort above all other factors. High illumination levels with freedom from high brightness and glare was our objective.

To meet these specifications, we chose fluorescent well-shielded, semi-indirect fixtures—suspended two feet from the ceiling—to provide freedom from glare.

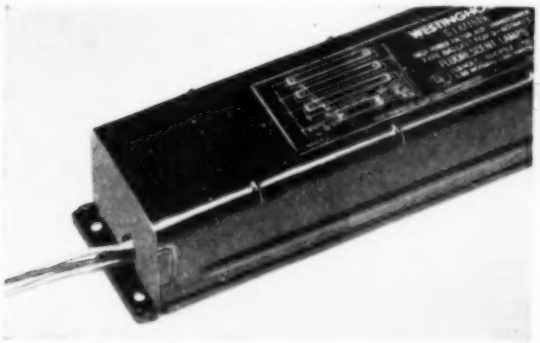
Chose Westinghouse CD Luminaires

The Westinghouse Type CD was most ideal for our purpose. It has translucent plastic sides and shielding, and emits just enough light to blend with the ceiling area. 72% of the light is directed up, making the entire ceiling area a low brightness light source. Initial footcandle readings on desk tops was 45. After six months, maintained illumination averaged 40 footcandles.

This plastic CD fixture is light, easy to handle, not easily broken and will not bend out of shape. Design is simple and well proportioned to room areas. It contains the new Westinghouse *lead-lag* ballast, which by test increases lamp life 10%. Unlike older series ballasts, the new *lead-lag* operates lamp circuits independently . . . which means simple relamping maintenance.

The contracting firm, Milan's Electric Sales and Service, used three men to install 107 of these Westinghouse CD fixtures *in a single day.* Careful advance planning, plus simple construction and ease of installation made this possible.

For your next school lighting job, consult Westinghouse. See or call your nearest Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. Ask for a copy of B-4566, *The ABC Plan for School Lighting.* J-04332



New Westinghouse *lead-lag* ballast is now comparable to older series ballasts in weight and size—gives all other inherent features of *lead-lag* at no added cost.

YOU CAN BE SURE...IF IT'S
Westinghouse

RESIDENCE LIGHTING Committee met at Corning Glass Center May 4 and 5, enjoying a tour of the Glass Center, luncheon and a lecture-demonstration on some of the recently-developed types of glass. Left to right, are Art Jaeger of Corning Glass Works; Caroline Horn; Mary Dodds; Priscilla Presbrey; E. W. Halteman; Y. L. Ripley; C. L. Crouch; Norman Vacha; Jan S. Reynolds; Myrtle Fahsbender; Committee Chairman Mary Webber; Eve Freyer; Mary Taepke; Stella Fetzer.

(Continued from page 17A)

Senior Fluorescent Inc., 70 Spring St. S. W., Atlanta 3, Ga. *Board of Managers* — R. E. Lawler, Judd Lough, J. D. Mitchell, Jr., O. V. Scott.

Heart of America Section

Chairman—J. Gordon McDonald, Graybar Electric Co. Inc., 1644 Baltimore, Kansas City 8, Mo. *Secretary*—R. R. Marvin, General Electric Co., 200 E. 16th Ave., N. Kansas City 16, Mo. *Board of Managers*—Jay Mears, S. J. Roberts, Frank Taylor, C. W. Thorsell.

Iowa Section

Chairman—Harold R. Weibel, General Electric Co., 301 Davenport Bank Bldg., Davenport, Iowa. *Secretary-Treasurer*—Melvin H. Galbraith, Approved Lighting Service, 111 Second St., N. E., Cedar Rapids, Iowa. *Board of Managers*—P. D. Anderson, D. F. Clutter, J. H. Hull, H. W. Johnson.

Maryland Section

Chairman—Lee W. Morgan, Potomac Edison System, 55 E. Washington St., Hagerstown, Md. *Secretary-Treasurer*—E. R. White, III, Consolidated Gas Electric Light & Power Co. of Baltimore, 1012 Lexington Bldg., Baltimore 2, Md. *Board of Managers*—J. M. Asher, E. S. Barrington, C. J. Berry, C. H. Bronner.

Michigan Section

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(Telecast continued on page 23A)

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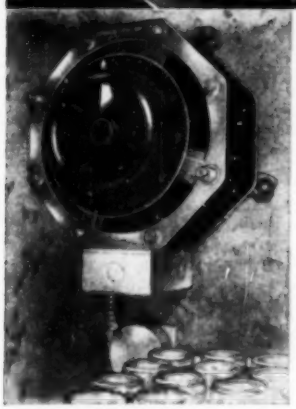

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ALAMO CHAPTER

Associate Member:
Williams, A. D., Graybar Electric Co., San Antonio, Texas.

ARIZONA CHAPTER

Associate Member:
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Associate Members:
Bagby, G. L., S. L. Bagby Co., Charlotte, N. C.
Jordan, C. C., Carolina Power & Light Co., Raleigh, N. C.

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Goble, L. W., Jr., Westinghouse Electric Corp., Cleveland, Ohio.
Spate, A. G., Cleveland Electric Illuminating Co., Cleveland, Ohio.
Stimac, W. G., Westinghouse Electric Corp., Cleveland, Ohio.

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Weeks, O. B., Hubbard-Lawless-Blakeley, New Haven, Conn.

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Braun, J. A., Morley Electric Supply Co., St. Petersburg, Fla.
Cummings, M. V., Miller Electric Co., Jacksonville, Fla.
Johnson, H. S., Richard A. Belsham, Orlando, Fla.
Mitchell, R. T., Mitchell Electric, St. Petersburg, Fla.
Smart, J. W., Richard A. Belsham, Orlando, Fla.

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Blount, H. R., Atlanta Fluorescent Co. Inc., Atlanta, Ga.
Noe, P. H., Westinghouse Electric Corp., Chamblee, Ga.
Reeves, M. T., Georgia Power Co., Atlanta, Ga.
Stanley, G. M., Westinghouse Electric Corp., Macon, Ga.

LIGHTING DESIGN competition winners in the Southern California I.E.S.-A.I.A. architectural student contest are shown here with the sponsoring members of the I.E.S. Seated: Roy Dahlin, Chairman of Southern California Section; Foster K. Sampson, Chairman for the May 6 meeting; William Gruen, Liaison Officer of I.E.S. and A.I.A.; standing: Donald R. Betzsold, Richard R. Olerich, D. W. Drazan, F. O. Goldberg, B. P. Urmston, Paul Hanson — winners in that order.

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Associate Member:
Jupin, J. E., Jr., Sanborn Electric Co., Indianapolis, Ind.

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Lobdell, H. R., Columbia Electric & Mfg. Co., Spokane, Wash.

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MARYLAND SECTION

Associate Member:
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(*Continued on page* 32A)

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(*Continued on page 26A*)

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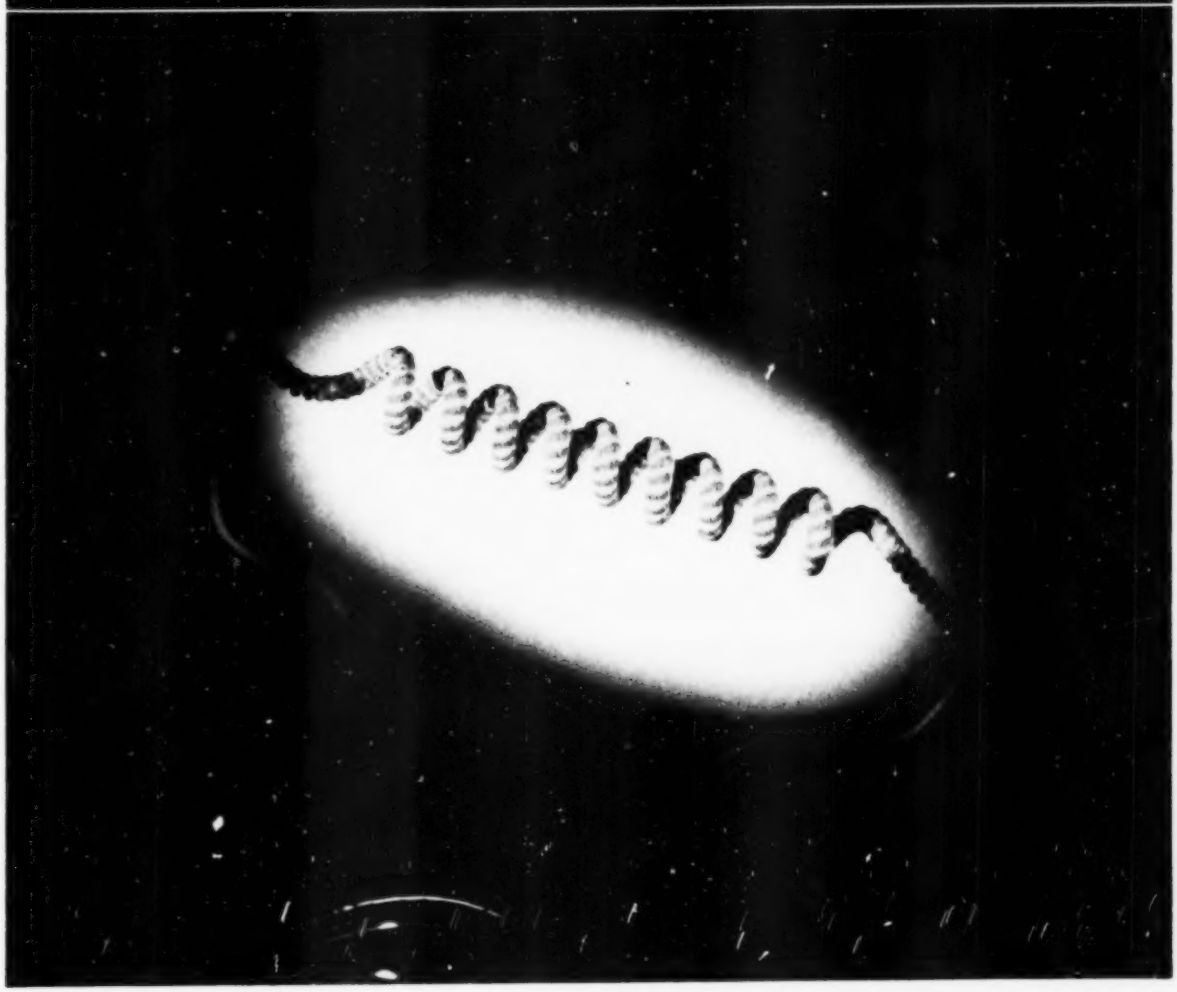

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(Continued on page 29A)

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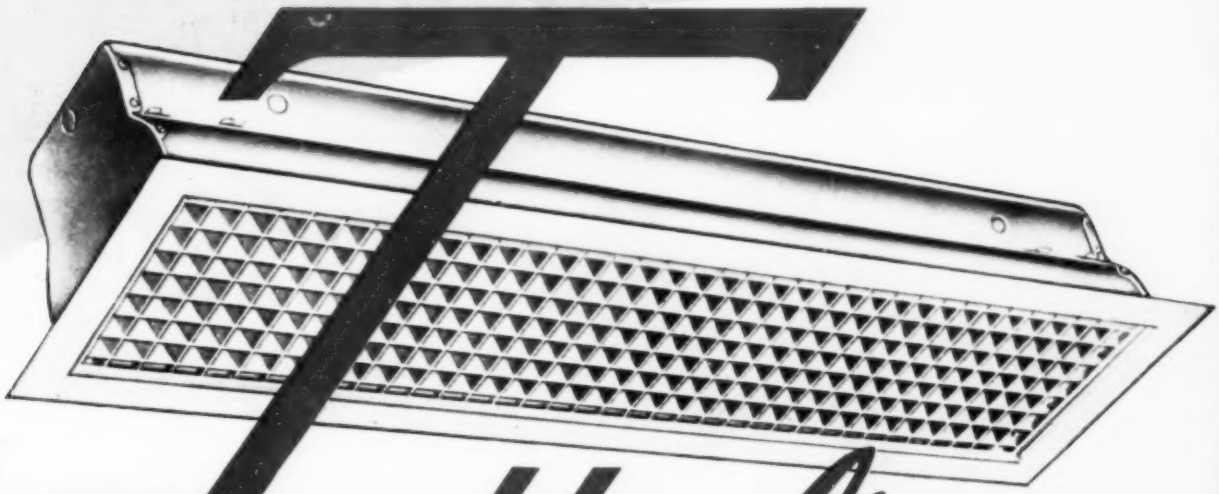

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for Interiors of Distinction

FEATURES LIKE THESE MEAN VERSATILITY "PLUS":

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CORNER FILL-IN
for 24" x 24" rectangular arrangements

COMPLETE RANGE OF SIZES

12" Regular
12" Shallow
24" Shallow
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BAFFLE LOUVER
for brightness requires extra-high light levels

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for maintenance, better lamp operation

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—general purpose, T-bar, surface ceiling, plaster frame, wood furring and channel furring (illustrated)

MOLDED PLASTIC LOUVERS
for wrap-around direction

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12"—1 lamp
12"—2 lamps
12"—3 lamps
24"—4 lamps
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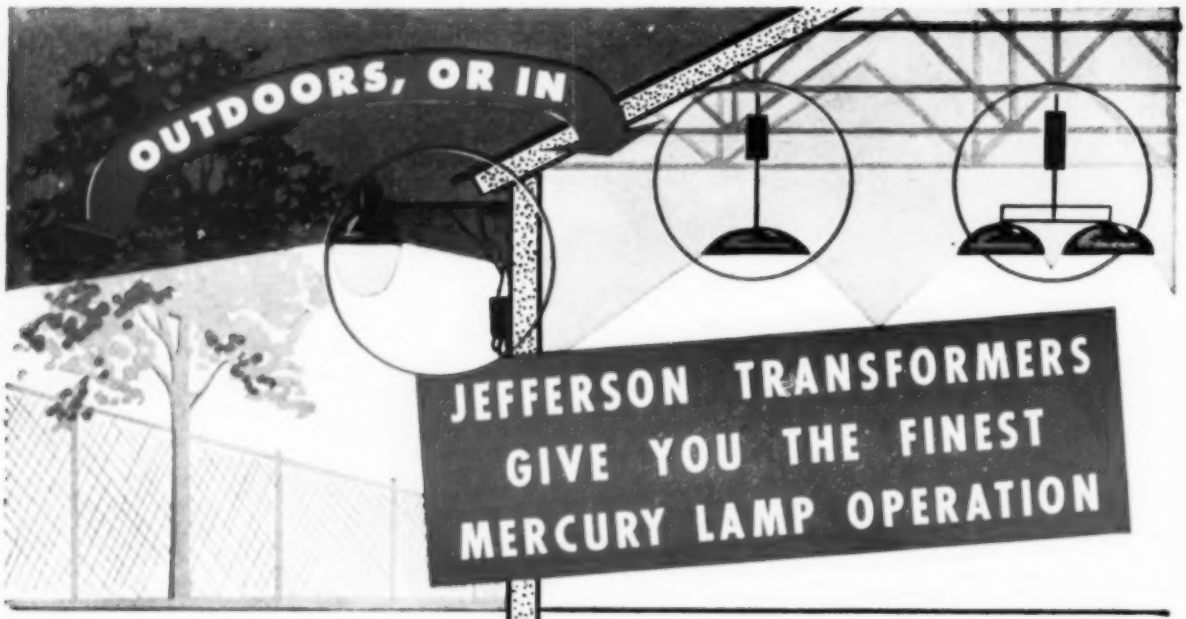
Benjamin Electric Mfg. Co., Leader Division, Dept. I, Des Plaines, Illinois, also makers of famous Benjamin lighting equipment and sound signals for Industry, Institutions and Commerce.

B-273



JEFFERSON TRANSFORMERS GIVE YOU THE FINEST MERCURY LAMP OPERATION

FOR OUTDOOR SERVICE

The finest transformers for outdoor operation of all H-1 400 watt mercury lamps. From core and coil to seamless hot-dipped galvanized case, every modern design and construction feature has been built in for longest transformer life and maximum lamp performance.

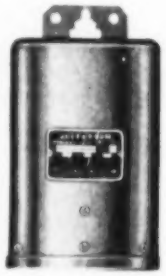
Every Jefferson Transformer is engineered to the highest quality standards. All are in deep drawn *weatherproof* cases for years of positive protection against the elements. Each has *all* the extra value features found *only* in Jefferson Transformers.

Streamlined hot-dipped galvanized case sheds water like a duck. No seams, no cracks, no place for moisture to seep in. Welded bracket has keyhole slot for easy mounting. Dura-Gray harmonizing finish for modern, attractive installations.

Large handhole gives easy access to color-coded tagged leads. Correct installation is quick, positive.

Patented Jefferson Adaptor converts wall and post mounting transformers to pole top units in minutes. Transformer stocks can be cut drastically as one type transformer can be mounted wherever needed—wall, post, or pole-top with an adaptor.

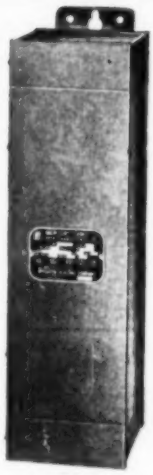
Universal Adaptor fits any pole top from 2-1/2" to 4" O.D. — fills every need. It's inexpensive, easy to mount. Provides a solid, weatherproof base for the transformer. Comes fully equipped with outlet fittings.



FOR INDOOR SERVICE

Jefferson two-lamp transformers cut installation costs by reducing wiring up to 50%. High power factor design delivers maximum lumens per watt. Failure of one lamp does not affect the operation or brilliancy of the remaining lamp. Stroboscopic effect is minimized since the two lamps operate out of phase with each other.

Mercury and incandescent lamp wiring facilities are provided at both ends in ample wiring compartments. Leads are color-coded and tagged. One-half and ¾" knockouts are provided in both sides of each wiring compartment and in both end plates for trouble free wiring. Condenser is mounted in a separate compartment for efficient cooling and maximum life.



TWO-LAMP TRANSFORMER

Jefferson Single Lamp Transformers give you every vital feature for top-notch lamp operation and economy. Press-fit riveted core, double varnished core and coil assembly, three primary taps (not just two), easy mounting brackets, and incandescent as well as mercury lamp leads out of both ends are a few of the outstanding Jefferson features. You get all these extra values in Jefferson Transformers, yet they cost no more than ordinary transformers.

Specify Jefferson for the best operation of every mecury lamp installation. New 16-page illustrated Bulletin 521-5 gives complete data on H-1 400 watt models as well as the new Jefferson Transformers for H-12 and H-15 1000 watt mercury lamps.

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BELLWOOD, ILLINOIS

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(Continued on page 30A)

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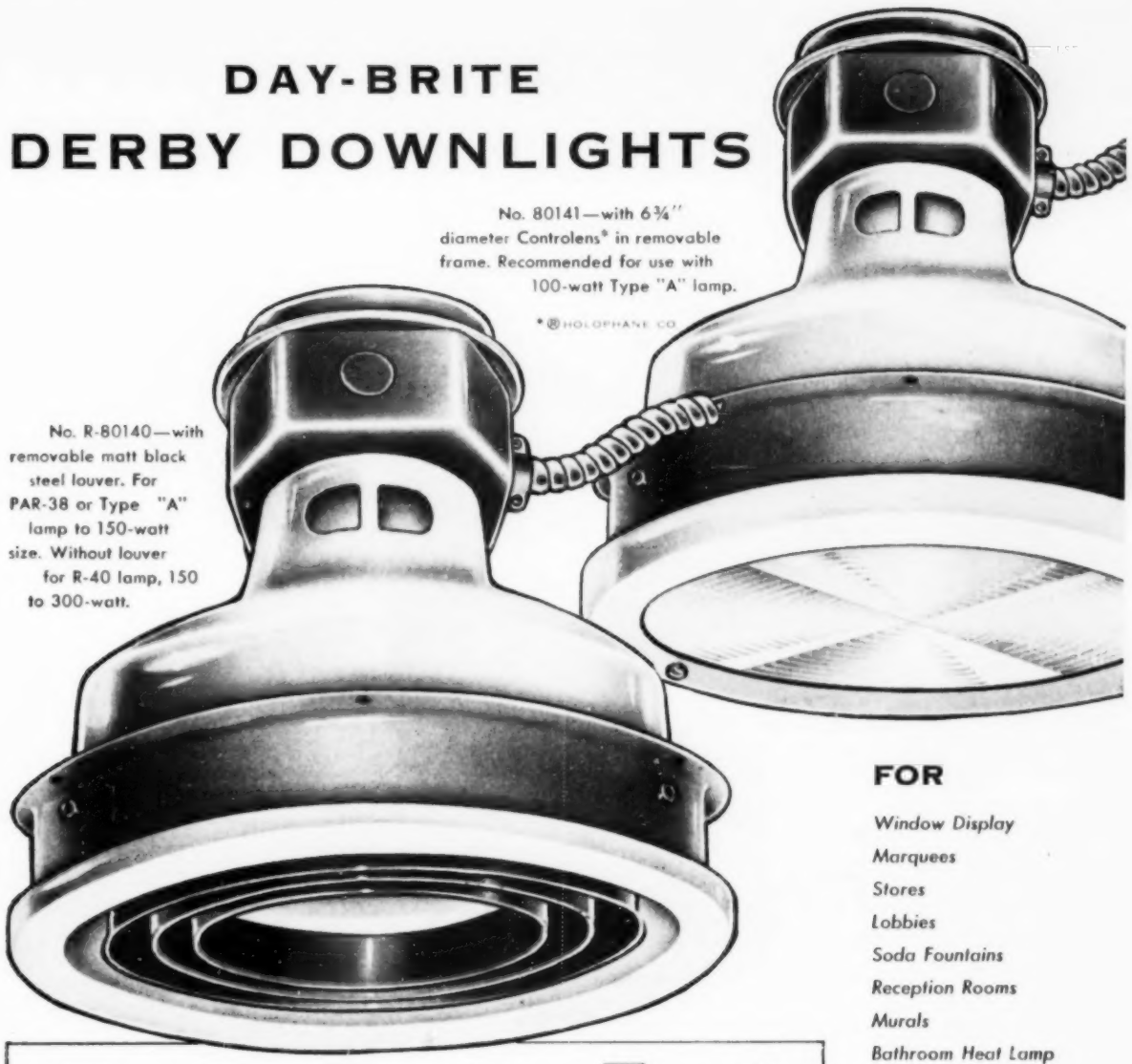

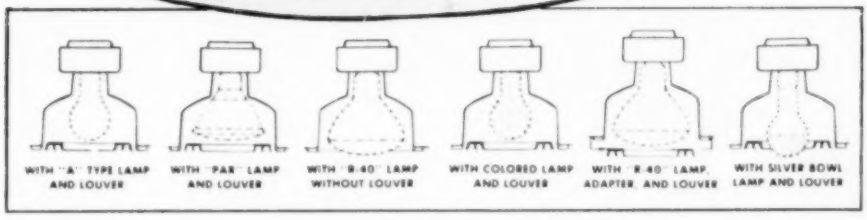
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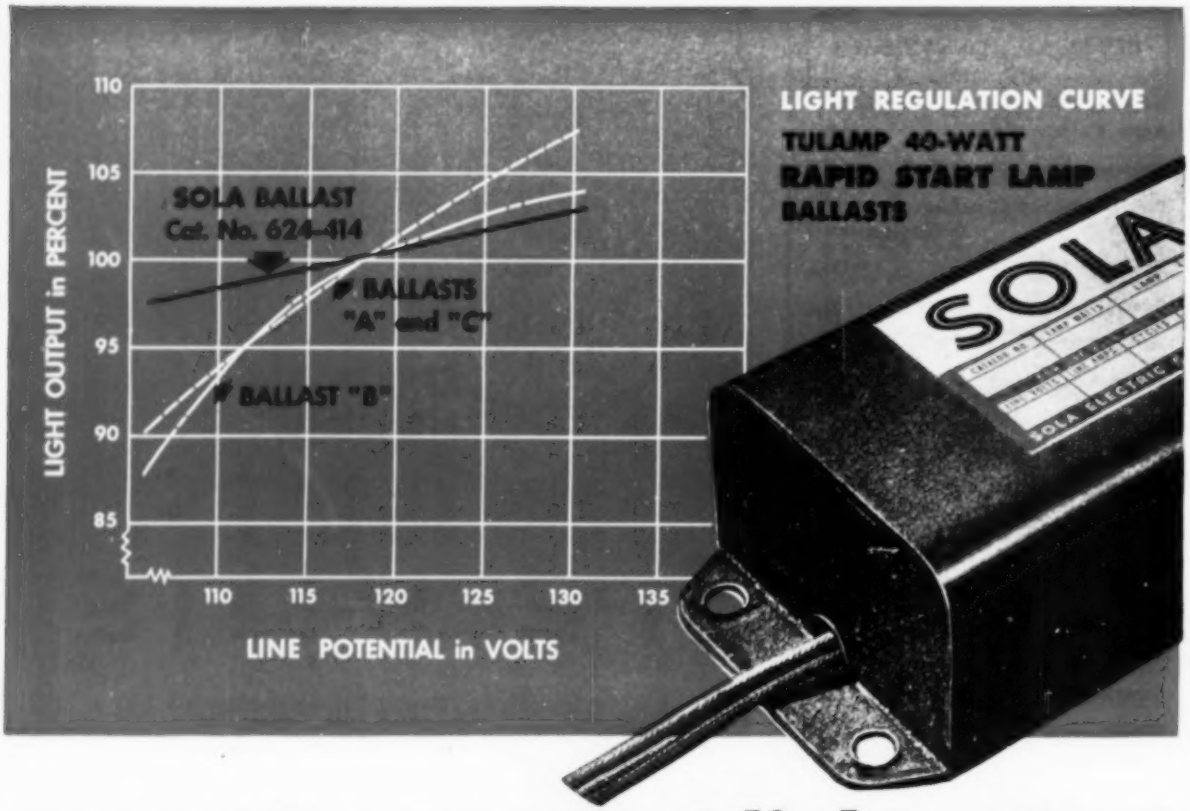

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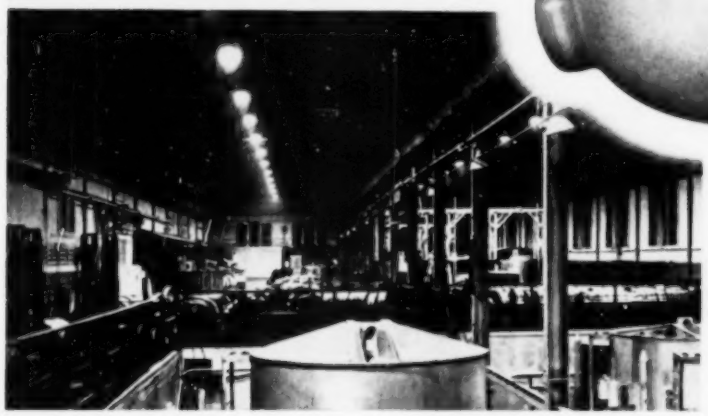

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